SEVENTY-FOURTH YEAR

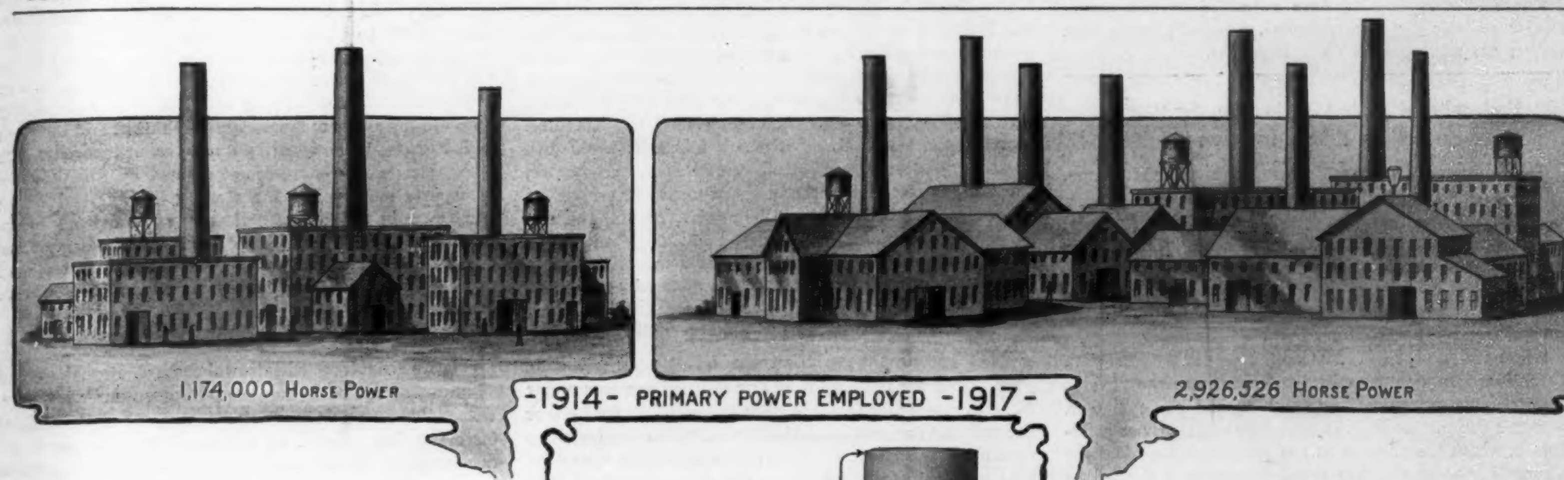
SCIENTIFIC AMERICAN

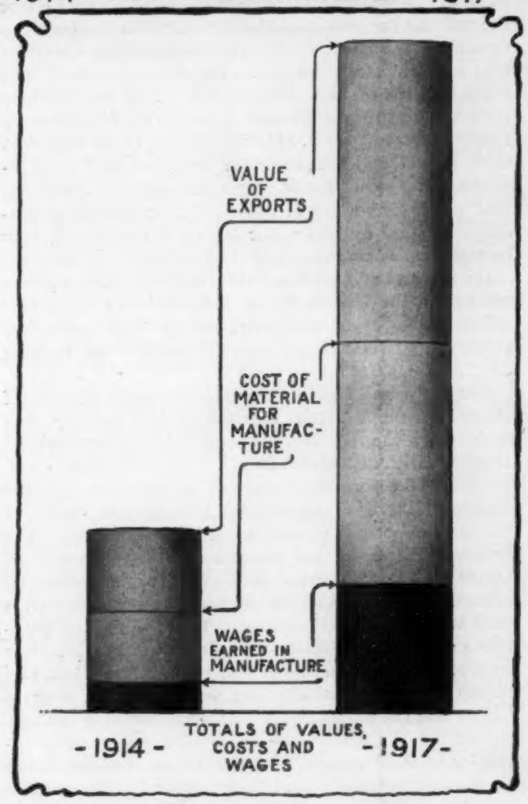
THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXIX.
NUMBER 15

NEW YORK, OCTOBER 12, 1918

10 CENTS A COPY
$4.00 A YEAR





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The power used and the wages earned in manufacturing export goods:

The cost of raw material employed, and (gross height of columns) the selling value. The upper segment of the columns represent miscellaneous expense plus manufacturing profit.

How the goods manufactured for export compare with our total industrial production

For every man making export goods in 1914, three men are so employed today

What Export Trade Means to American Industry

THIRTY years ago the foreign commerce of the United States was carried on on the strength of our agricultural exports. Fifty per cent of all the goods sent abroad by this country consisted of foodstuffs, 30 per cent was raw materials, and but 20 per cent was contributed by the factory. Since then matters have changed vastly. The industrial producer has usurped the place of the farmer and the miner. When the war broke out in 1914, half of the nation's export consisted of manufactured goods; raw materials still accounted for approximately a third; but the farmer's share had declined to 18 per cent of the total.

The transition of the country from one exporting food to one supplying the world with manufactured goods has proceeded with a speed not even equalled by the rapid industrial development of Germany following the Franco-Prussian War. Such a change could not have taken place without leaving its mark on the economic life of the nation. Let us consider what these figures mean for the present and what they promise for the future.

During the year 1914, when the last industrial census was taken, the industrial production of the United States was estimated at $24,246,435,000. The cost to the nation of producing this quantity of salable goods was $20,535,245,806, leaving a manufacturer's profit of $3,711,189,194. For the materials required in manufacture $13,701,682,122 was paid; $4,079,332,000 went into the pockets of the wage earner. The balance of the manufacturing expense is chargeable to fuel, taxes, rent and other items of indirect cost.

For the same year our exports of manufactured goods were valued at $1,305,304,886, or 5.3 per cent of the total industrial production. One-twentieth of the capital and labor of American industry was therefore employed for export work; to satisfy the demands of our foreign customers, 378,898 men and women were working in our factories, and as their share of the profits which the nation derived from its foreign commerce they received $210,000,000. For the manufacture of export goods, raw materials costing $728,000,000 were used; and $195,000,000 was added to the dividends of American factories by taking care of the foreign demand.

This was in 1914. Since then our industrial exports have risen beyond all precedent. For 1917 they were valued at $4,887,594,078, the increase being felt in practically all industries, but chiefly in those dealing most directly with the war and the needs created by it. The grand increase of 374 per cent shown for all manufactures would of course suffer some scaling down if it were attempted to make allowance for increased prices. While this cannot be done with great accuracy, it appears that wages have gone up about fifty per cent and raw materials from 20 to 100 per cent; so 50 per cent seems as reasonable a figure as any for the rise in manufacturing costs as a whole. On this basis, $3,300,000,000 might have paid for our industrial exports of 1917, at the old scale; and even this is a sufficiently impressive showing. The manufacturing profit from last year's export of manufactured goods was $842,000,000. But this huge sum is a small amount in comparison with the total benefits reaped by workers, farmers, merchants and investors from the transaction of foreign commerce. To produce all the merchandise required by our foreign customers for 1917, 1,069,000 men were employed. In the steel and iron and cotton industries combined, exports rose from $249,954,677 for 1914 to $1,402,573,416 for 1917, while the number of workers necessary to handle the output jumped from 81,000 to 322,000. These figures may be brought nearer the human understanding when it is stated that to provide all the labor required for export goods in 1914 would have used up the whole of the then existing available labor force of New York State; while manufacture of our industrial exports for 1917 would have taxed the combined facilities of the South Atlantic and South Central States, with most of the West North Central group thrown in for good measure.

Labor has claimed and received its wages. Its total share from the export business of 1917 was $920,000,000; and even this represents only the comparatively small amount paid over to the American wage earner for work immediately connected with the manufacture of our export stock. It does not take into consideration the large sums paid by the producers of materials which ultimately went into goods manufactured for export. And after all, every form of industrial improvement represents labor of some sort or other. When the furniture maker buys timber, he pays for the labor of cutting the trees and transporting the boards to him. The potter pays not alone for the clay but equally for the labor entailed in its production and preparation. Cotton in its virginal form grows wild; but its selling price is governed by the labor which was performed in its planting, harvesting, and preparation for the market. If our factories, then, have paid $2,688,000,000 for the raw materials which went into their export orders, they have only rendered another tribute to labor; for in the last analysis, any material is worth little more than it costs to make it available for use.

We must not forget that, as to raw materials, the United States is in the very happy position of being able to provide most of its own industrial raw material from its own resources. Raw materials in crude form and materials for further use in manufacturing were imported into the United States during 1914 at a value of only $1,747,000,000—or a fraction more than 12 per cent of our total consumption of industrial raws. Deducting this from the total, we find that of the annual raw-materials bill of our manufacturers, some $12,000,000,000 is paid to home producers; and by means of another simple computation, we discover that of this total, two billions is paid, ultimately, by the foreign customers of those manufacturers.

It is of interest to trace this two billions down to its destination, and see how it was distributed among all classes of workers and among all communities. The

(Continued on page 300)

SCIENTIFIC AMERICAN

Founded 1845

Published by Munn & Co., Inc., 233 Broadway, New York, Saturday, October 12, 1918

Charles Allen Munn, President
Orson D. Munn, Treasurer, both at 233 Broadway

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Federal and State Coöperation for Post-Bellum Reconstruction

As most of us are aware, Franklin K. Lane, Secretary of the Interior, has consolidated the Woman's Committee of the Council of National Defense and the State Councils' Section of the same body; but we question whether the possibilities of this consolidation have been fully realized—even by those who have followed most closely the development in the unification of our war effort.

When the Council of National Defense was created, a small section was organized to coördinate the various state defense organizations, and at the same time a woman's committee was organized to handle those problems in which the support of the women of America was required. Originally, not much attention was paid to either body. They were not even housed in the building erected for the National Council, but were left more or less to shift for themselves. The State Councils' section, however, took up seriously the problem of the unification of state effort, and little by little, the work grew and became more fully organized.

In the very beginning Grosvenor B. Clarkson formed the big conception of not only unifying the actions of the various organizations but also of carrying the organization down, not merely into every county, but beyond that, into every community in the country. This system of organization has been carried into full effect, and both county and community defense councils are completely built up.

At the same time, the woman's committee was organizing in a parallel fashion, so that there grew up in every state in the Union, in more than 3,000 counties, two complete fighting organizations, with their members pledged not only passively but actively for the carrying on of the war. The woman's division was headed by such well-known figures as Dr. Anna Howard Shaw, Miss H. J. Patterson and Ida M. Tarbell.

These two organizations offered to the Red Cross drives, to the Liberty Loan campaigns, to the calling of nurses, to the enrolling of shipyard volunteers, to the support of the Food Administration, the Fuel Administration, the Draft Boards, the Employment Service, and to every other arm of the Government, a medium by which their various problems could be taken down to the last man, in the farthest back county of any state between Maine and California. They took up the problem of Americanization, the problem of limiting building construction, and in fact, all of the problems which went toward putting the nation on the war footing. In many states, the work of these organizations became combined; in all other states, they worked in close coöperation.

With the creation of the War Industries Board and the taking over by the various departments in Washington of many of the functions of the original Council of National Defense, the work of these two "home folks" organizations became more and more important, with the result that Secretary Lane, who, because of his position as the head of the Interior Department, is particularly interested—not only for the present but for the future—in civilian effort and morale, took up the problem of unifying the two organizations into a single fighting unit—the new "*Field Division of the Council of National Defense.*" The personnel of the governing body speaks for itself: The Secretary himself is chairman, Dr. Shaw is vice-chairman, while Clarkson becomes active director of the new division.

The placing of the work under the control of the Secretary of the Interior is particularly fortunate, as is the selection of Dr. Shaw as vice-chairman. It is also particularly fitting that Clarkson should be director and active head of the organization, for the reason that, as the secretary of the Council of National Defense, he has followed as closely as any man in Washington the working out of the various problems brought on by the war.

It is not only the intention of those who head the new Field Division of the Council to keep this organization intact for the duration of the war, but also to use it as the machinery for reconstruction in the years following the signing of the peace treaties. When that time comes, it is very probable that the various states will face peculiar problems of their own in providing homes for soldiers, in the working out of the Americanization plan, and the rebuilding of the business of the nation. It is apparant that each state, furnishing its young men for overseas service, will desire these men to return to their own homes; and if these men are to do so, the various states must compete in their offers of inducement whereby these men can take up again the problems of their own livelihood.

There will be the problem of the merchant marine and of our coming duties in arranging to do our share in the reconstruction problems abroad. The farmer in Kansas must be shown that he is as much interested in the building up of overseas business as he is in the development of resources in his own state. The people on the Pacific coast, who look toward the Pacific, must have some unit of organization whereby they can build up their Oriental trade. The factories of the East and North must realize their overseas markets: the South must have means by which it can prosper. Above all, the various sections of the country must themselves be prepared to do their part in this reconstruction, and this work must be unified. The new Field Division of the Council offers a ready-made machine for reconstruction, and the consolidation was made for that purpose.

Unification of Our Railroad Systems

So manifest have been the advantages resulting from the unification of our railroad systems under a single management, that it is unlikely that either the railroad companies or the general public will wish to return to the system of individual competitive operation that existed before the war. The summary of the first seven months of Federal operation which has recently been offered to the President in the form of a report by Director General W. G. McAdoo reveals, to our thinking, such logical and commonsense procedure and such indisputable advantages of operation resulting therefrom, that permanent unity of control (under present ownership), whether by Federal or private management, may be reckoned as a certainty of the future.

On the first of January, 1917, the total steam railway mileage in the United States, including all tracks, was 397,014 miles, owned or controlled by 2,905 companies, employing 1,700,814 persons. They had outstanding $10,875,000,000 of bonds, and $8,755,000,000 of stock.

For the sake of public convenience and efficiency of operation, the railroad mileage of the country was divided by the Director General into seven Regional Districts, with a Regional Director in charge of each, and District Directors in charge of sub-divisions of the Regional Districts, and Federal Managers in charge of the more important groups of less important lines. The Regional Directors are subject to the authority of Director General McAdoo at Washington; but since all of them are men of wide experience as railway executives they are given large discretion. This permits the members of the central staff at headquarters to give their time to the larger questions that come before them, and to the essential administration work. With a view to facilitating the movement of traffic and securing the best service for the public, the limits of administrative authority of the Regional Districts are determined rather by the railway lines than by geographical boundaries.

It followed logically from the placing of the railroads under Federal control, that the presidents and other officers of the railroad companies were released from all responsibility for the operation of their properties. This avoids all ambiguity of obligation. The officers of the corporations are left free to protect the interests of the owners, stockholders and creditors, and the Regional Managers have a direct and undivided responsibility and allegiance to the United States Railroad Administration.

As showing the economies effected by the unification of our railroads, attention is drawn to the fact that, although the reorganization of the operating forces has resulted in a reduction in the number of officers and in the aggregate of the salaries paid them, it has not involved any impairment of efficiency. Thus, under private control of the railroads there were 2,325 officers drawing salaries of $5,000 a year and over, with aggregate salaries of $21,320,187. Under Government control 1,925 officials are doing the same work for $16,705,298, a reduction of 400 officials and a saving of $4,614,889 per annum. Under private control, salaries up to $100,000 per annum were paid officers of railroad corporations; under Government control, the highest salaries are $50,000 per year.

Regarding this question of salaries, we cannot do better than quote Director General McAdoo where he says this reduction "has not been effected by forcing the experienced men appointed by the United States Railroad Administration to accept salaries incommensurate with their responsibilities, although in numerous instances these salaries are substantially less than those they had been earning as officers of the railroads or could earn in private employment. It is not only equitable but necessary that they should be justly remunerated. It is not a question merely of operating the railroads during the period of the war, but it is a question of the post bellum period as well, when railroad work must continue to be sufficiently attractive to draw men to it of the right quality and caliber."

We are informed that when the Government took control on the first of January, 1918, the railroads were in a "deplorable condition." In addition to the strain of a winter so severe that it will long be remembered, the motive power was seriously crippled, and on the Eastern lines there was a bad blockade of unloaded cars at the terminals and elsewhere. The number of loaded cars, above normal, was about 180,000. Evidently the first task of the administration was to relieve this situation, and the whole energy of the new Federal organization was devoted to this task. By the end of August there was no accumulation of loaded cars above normal on the Eastern lines. Unfortunately the legislation making available an appropriation of $500,000,000 for a revolving fund did not become law until March 31st, and the plans laid down were necessarily tentative. Since that date much has been accomplished toward coördinating the transportation facilities for winning the war and for the service of the public. We lack space to discuss the applications of this fund here; so we must put that discussion over until our next issue, when this review of railroad conditions under Federal operation will be concluded.

Problems of Peace

Bulgaria's withdrawal from the great conflict will not be a signal to relinquish our war efforts. To be sure the elimination of one of the allies of Germany has proved as encouraging to us as it has disheartening to our enemies, but we are not going to become over-confident at this first concrete evidence of the crumbling of Teutonic ambitions. Nevertheless, while we are pursuing the war with the utmost vigor, it is high time that we took serious thought of conditions that will follow the final conclusion of peace.

The Scientific American has frequently urged the necessity of making preparations for peace; even before the United States was involved in the war, we called attention to industrial conditions that would follow the war and discussed the means of meeting these conditions. From time to time we have repeated the warning that the declaration of peace must not find us unprepared. In fact, the problems of peace are likely to prove very serious indeed. Never before has there been a war in which the industries, particularly mechanical industries, have played so important a part. In order to put forth our whole strength we have endowed our Government with powers that were undreamed of a few years since. We have willingly subjected ourselves to a species of paternalism that is decidedly un-American and which would not be tolerated for a moment in time of peace. But how long will it take us to come back to a normal peace basis? If the change takes place suddenly the forces which the Government has been controlling, on suddenly being released, will burst forth like the waters through a broken dam, with inevitable disaster to the country. Just how normal conditions are to be restored is a problem which needs the utmost consideration on the part of our Government. Millions of men will have to be returned from Europe and reintroduced into civil life. It will take a long time to transport these men back across the waters, and then it may not be advisable to release them suddenly for fear of an industrial deluge. Then we have the vast industrial army; when the Government no longer needs such war materials, what is to be done with the men who have been receiving high wages for the making of shells and guns?

At the conclusion of the war we shall find ourselves possessed of a vast merchant fleet. Are we to continue to operate these vessels under the faulty seamen's laws that now prevail in this country? Are we suddenly to cease building ships; and if so what is to become of the vast ship-building plants along our coasts? At the end of the war we shall find ourselves possessed of gigantic fleets of airplanes. Are we going to let these machines lie idle, or is there some service that they can perform with profit? Hundreds of thousands of women are employed in our factories to take the places of the men who have been called to the colors; are these women going to return to their former duties or will they insist on continuing to work in factories? In the latter case are not serious labor troubles in store?

The problems of peace are endless. England and France have both made preparation to meet them by the appointment of commissions to weigh them and seek their solution. An effort is now being made to have such a commission appointed by our Government. There is plenty of work ahead of such a body. If progress along the fighting fronts continues at its present rate, the problems of peace may confront us long before we are ready for them. The committee should be at work now. There is no time to lose!

Electricity

Highest Telephone System in the World.—According to the *Telephone Engineer*, Mr. G. D. E. Mortimer, a mining engineer of Point Loma, Cal., claims to have the highest telephone system in the world, the installation being at an altitude of 15,500 feet above sea level. This telephone system is located at Sonata, Bolivia, South America, where the installation of a telephone system for a certain mining company, between various parts of the mine and the town of Yani, has just been completed. The total length of the line is 10½ miles, the installation being at an altitude of 15,500 feet.

Voltage Stabilizer to Reduce Flickering in Lamp.—In the *General Electric Review* a device was recently described which is intended to check the flickering of lamps arising through fluctuations in voltage caused when large motors are started up on the same system. The apparatus, which is described as a voltage stabilizer, consists essentially of a highly reactive transformer having a primary through which the current to the motor flows, and a secondary in series with the lamp circuit. The rush of current when the motor is started up excites the magnetizing circuit of the stabilizer and induces a voltage in the lamp circuit in phase with the lamp voltage, thus tends to maintain the potential differences across the lamp's constant. The transformer magnetic circuit contains an adjustable air gap, the intention of which is to cause the drop in the motor circuit to be in quadrature with the line voltage.

Radio-Operated Steel Soldier.—An "automatic soldier" is one of the latest developments in war weapons, according to *Wireless Age*. A Danish engineer has recently taken out a patent for an apparatus to which he has given his name. It is a steel cylinder normally within a larger cylinder, the whole being sunk in the ground vertically. By means of a mechanism operated by wireless the inner cylinder rises to a height of 18 inches and an automatic rifle mounted on the inner cylinder fires 400 shots in any given direction. These "automatic soldiers" can be controlled from a central position four or five miles behind the line of defense, according to the inventor's claims. They may be seen by the enemy only when they rise. From trials already made it has been shown, it is reported, that a few hundred of these steel soldiers can easily defend a position against infantry attacks, however numerous the opposing force may be. In order to overcome the "automatics" they must be destroyed one by one. There is no one to quit and cry "Kamerad" when the attacker does get too close.

A Photo-Electric Cell Yielding Alternating Current.—Some interest was excited last year by the experiments of Mr. T. W. Case of New York, on some new forms of photo-electric cells which gave an appreciable E. M. F. under the influence of light. We observe that an account of some further researches by Mr. Case has appeared in the Transactions of the American Electrochemical Society, wherein he studied the photo-electric action of voltaic couples, one electrode of which was eliminated, while the other was kept in the dark. A plate or wire of copper was immersed in solutions of various copper salts, *e. g.*, copper formate and acetate, became coated with a film of some lower oxide or halide. When subsequently this coated copper was coupled with an electrode of clean copper (or silver), and one of the electrodes illuminated, a current of 0.11 volt was generated, the illuminated electrode being the anode. He suggests that the film on the copper consists of cuprous oxide or hydrate, which is oxydized under the influence of light, but subsequently dissolves in the acid of the electrolyte. The E. M. F. slowly dropped under continued illumination, but when the previously dark electrode of the exhausted cell was illuminated, the current reversed. By interposing a revolving screen in the beam of an arc lamp so as to illuminate the two electrodes alternately, Mr. Case obtained a steady alternating current, and the electrodes did not appear to disintegrate.

Reading Water Meters at a Distance.—An electrical indicator has been designed by means of which water meters can be read at a distance of six miles, according to a recent issue of *Electrical Review*. An irrigation company may have a canal or ditch, with several laterals leading from it, that are several miles apart. By means of this device a central office may be connected with each of these laterals, and can know the exact amount of water that is passing through any of the laterals. The central office is also informed by the indicator as to the total amount that has passed through any lateral. By means of another electrical device the valve leading to the laterals can be opened or closed from the central office, making it unnecessary to send an employee to open or close the valve or to read the meter. It can readily be seen that this is a great labor-saving device. When it is not necessary to know the total amount of water that has passed through the meter, the common telephone can be used. In this case the telephone is connected with the meter in such a manner that each time the meter makes one revolution, a click is heard in the receiver of the 'phone. By knowing the capacity of the meter, and ascertaining the number of clicks to the minute, it is an easy matter to figure the approximate amount of water that is passing through the meter. If a sufficient amount is not passing through the meter, the other electrical device may be manipulated and the valve opened until the proper amount is delivered through the meter. A number of meters may be connected to the ordinary telephone receiver, by providing an ordinary telephone switchboard, and plugging in on any line.

Science

A Proposed Italian Atlas of the World.—Ambitious plans are on foot in Italy to produce a great atlas of the world which will make Italians independent of the renowned German atlases of Stieler, Anfree, Debes, etc. The promoter of this enterprise is the Touring Club Italiano, which has already issued excellent touring maps and guide-books to Italy, and the scientific editor is to be Prof. Olinto Marinelli, of Florence. The work will appear in parts, about sixteen maps to the year, and will take eight or ten years to complete.

Handbooks on the Physical Properties of Metals and Alloys.—The U. S. Bureau of Standards has recently begun the publication of a series of handbooks, modestly described as "circulars," dealing with the physical properties of individual metals and alloys. These works, comprising text, tables, diagrams, classified bibliography, etc., are destined to become an indispensable part of scientific and technological libraries, as they bring together trustworthy information such as is not now, in general, conveniently accessible elsewhere. The first circular published dealt with invar and similar nickel steels; one on copper has just appeared; and a third, in preparation, is to deal with iron.

Color Blindness.—An important Public Health Bulletin on this subject, by Dr. G. L. Collins, recently issued, leads the author to the following conclusions: Color blindness is best detected by testing with colored lights of known spectral composition. The Eldridge-Green lantern will satisfactorily divide the color blind into the dangerously color blind and the harmlessly color blind if the test is properly applied. The Jennings self-recorded worsted test should not be used for testing sailors or trainmen, but possesses certain practical features which render it superior to other tests where great accuracy and a classification of color defects are not essential. Among healthy persons in this country about 8.6 per cent of men and 2.2 per cent of women are color blind. The condition is dangerous in about 3.1 per cent of men and 0.7 per cent of women.

The Effects of Deficient Soil Oxygen on the Roots of Plants have been made the subject of extensive experiments by B. E. Livingston and E. E. Free during the past three years. Observations on the isolated and controlled root systems of the higher plants, the aerial portions being exposed to the atmosphere, show that response to a deficiency of soil oxygen differs greatly with the species. The first noticeable effect of oxygen deprivation is an interference with water absorption by the roots. In certain species this process ceases completely in 24 hours. The roots die and become partially disintegrated. The earliest symptoms of injury are found on plants having the largest root systems. The evidence suggests that the cause of injury by oxygen exclusion is an interference with the respiration of the protoplasm in the root cells.

Soy Bean Plants for Measuring Climate.—Prof. B. E. Livingston and F. T. McLean, of Johns Hopkins University, have from time to time emphasized the value of plants as automatically integrating instruments for measuring the effective climatic and weather conditions of any locality, comparing climate with climate, season with season, etc., and they have especially made use of the soy bean for this purpose. In their experiments soy beans are grown in pots always filled with the same kind of soil, the seed being soaked in water at a given temperature for a certain time before planting. Measurements are made on the plant after two weeks and again after four weeks. New cultures are started every two weeks. The efficiency of the weather for any two to four week period at any station may be compared with that for any other period at the same or another station. It is desirable in such experiments to ascertain the dry weight of the plant at the time of measurement, and still keep the plant alive and uninjured. This is done indirectly by measuring the leaf area of the plant, which, in the case of the soy bean, is found to be nearly proportional to the dry weight of stem and leaves. Lastly, Mr. F. M. Hildebrandt has recently published in the Johns Hopkins University *Circular* directions for obtaining the leaf area from measurements of the axes of the elliptical leaflets.

Earthquake Weather.—A recent article in the *Monthly Weather Review* revives the old question whether a particular type of weather is or is not commonly observed to prevail just before an earthquake. The expression "earthquake weather" is frequently heard in California and in some other regions subject to earthquakes. It is applied to a heavy, oppressive feeling in the air; heat, calm, little cloud and more or less haze. This is much the same kind of weather as prevails before a summer thunderstorm, and perhaps the popular mind has extended the association from one phenomenon to the other. Professor Humphreys, in charge of the seismological work of the U. S. Weather Bureau, has made the plausible suggestion that the "earthquake weather" notion is probably of psychological origin; the general state of irritation and sensitiveness produced by the kind of weather above described inclines us to sharper observation of earthquake disturbances and accentuates the impression they make on our senses; thus we retain more vivid memories of the quakes occurring during such weather than of those occurring on more soothing days. In some countries particular forms of cloud are alleged to forebode earthquakes, and there is a widespread belief that earthquake shocks produce mist, fog and rain. The idea that barometric fluctuations are connected with earthquakes rests upon a much more substantial foundation.

Automobile

Hydrogen Gas for Fuel.—Owing to the scarcity of gasoline in Switzerland it is reported that experiments are being made with a view to using hydrogen gas as a fuel for motor cars. This gas contains practically twice the calorific value of gasoline, but, owing to its low density, requires a much higher compression as compared with coal gas in containers, so that considerable alteration will probably have to be made in the engine to make its employment practical.

Compressed Gas as a Motor Fuel.—In view of the threatened shortage of gasoline, and the comparative success of gas as a motor fuel in England, it has been proposed, in this country, to use compressed natural gas. The question will be worth considering if the restrictions in the use of gasoline become more stringent as we have abundant supplies of natural gas; the principal difficulty being that of distribution, which might limit its economical use to the regions within the gas zones.

A Departure in Springing.—Everyone knows the many difficulties incident to the use of the standard leaf spring, and in the control of its action. A British maker has recently evolved a new system of springing that appears to have distinct merits in simplicity and economy in manufacture, at least as applied to the lighter class of cars. His idea is to hang the chassis on levers of the bell-crank order, and to interpose helical springs in compression between the short arms of the levers. It is claimed for this arrangement that the uncomfortably sharp rebound of the ordinary leaf spring is totally eliminated, thus doing away with the necessity for shock absorbers.

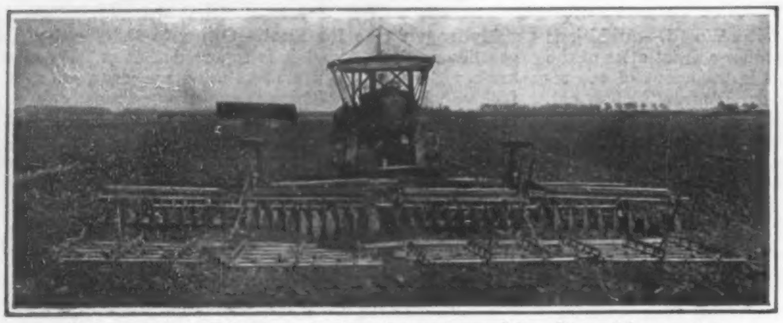
Decarbonizing Cylinders.—Some inventive genius has discovered a method of clearing carbon from the cylinders that is certainly simple, and is said to be quite effective. All that is necessary is to put a teaspoonful of common salt into each cylinder, through the spark plug opening, and then run the engine fast. As the operation creates quite a mess in the neighborhood of the exhaust it is not exactly desirable to do the work indoors, and it is best performed out on the open road. As it is quite difficult to start the engine with the salt in the cylinders, it is well to have the engine well warmed up beforehand.

How to Run with a Punctured Inner Tube.—The following is a very good makeshift when no regular repairs can be made. At the punctured spot, twist the tube about just as if it were a piece of cloth being wrung out. Wrap around this part with string or any kind of tape making a tight ligature on each side of the puncture and then wrap the place with rags, waste or anything which will serve to round out this part of the air chamber to the same size as the rest; then replace in the tire as if it had been well repaired. It is claimed by persons who have used this method that the car can be very well run home or to any suitable place for repairs lying within reasonable distance.

Economizing Fuel.—Facing a shortage of gasoline as we are, it is strange that a more careful study is not being made of methods of economy that are open to all. One of these methods, which has been alluded to before in this column, is a better understanding of the functions of the throttle and the spark control. Too many drivers regulate their speed almost entirely by means of the spark lever, and hardly ever vary the adjustment of the throttle in a day's run on ordinary roads. If more study was devoted to the use of the throttle not only would a very noticeable economy of gasoline be effected, but there would be much less trouble from overheating and carbon in the cylinders.

Steam Power for the War Zone.—A British motor driver, who has been at the front for several years, and whose experience has been most varied, in speaking of traffic conditions in the war zone, gives it as his opinion that steam operated cars would be of extreme value; and he comments on the fact that practically none of the class are seen. His reasons for this opinion are that on congested roads, and especially roads so badly cut up by the heavy traffic, and gullied by shells, the great flexibility of the steam car would not only make it easier to drive, but it would do its work better because of the reduced shocks incident to constant stopping and starting. Another advantage that would appeal strongly to car owners in districts remote from commercial lighting facilitates would be the possibility of letting it run unattended all night for generating electric light, a proceeding to be avoided with an internal combustion motor if possible.

After-the-War Cars.—For some time a favorite topic for speculation by the British automobile papers has been the kind of car that will be turned out after the war is over; and in view of the unusual experience that is being had with motor vehicles of all kinds in war work many people apparently anticipate that the car of the future will be radically different from present designs. These ideas have also prevailed to a limited extent in this country, but an authority on the subject points out the wonderful work that these vehicles are doing under the most adverse circumstances in the war area, and have been doing ever since the beginning, and that this is ample proof of the remarkable degree of perfection that has already been attained in automobile construction. From this point of view it would seem that no radical changes are necessary, or to be expected; although undoubtedly many improvements in details will naturally be forthcoming when all the facts have been studied, and our manufacturers have time to undertake them.



Three operations in one—plowing, harrowing and levelling with a tractor

Tractor hauling a string of loaded trailers over the public highway

Out-of-the-way Jobs for the Tractor

A Few of the Unexpected Places Where the Mechanical Crawler Has Proved Its Value

By Arthur L. Dahl

THE principal purpose of the tractor is to furnish power on the farm, and it is customary to think of it as taking the place of horses. This is hardly true, however, because statistics show that, although tractors reduce the number of horses needed on a farm, they do not entirely supplant them, except in a few isolated instances. Tractors as at present constituted are suitable for use only on fairly large farms or orchards, and there are some things on all farms that can be done better with horses. On the other hand, owners of tractors are finding new uses for their machines every day, and far from being suitable only for plowing and doing the regulation work of raising crops, the modern tractor is proving its usefulness in doing many things entirely apart from ordinary farming operations. And from the standpoint of its versatile ability, the tractor will become more and more useful to all classes of farmers, the small as well as the large, until eventually it will become a necessity, just as horses have always been.

The development of the tractor has probably been more rapid than that of even the automobile. From a heavy, awkward machine it has evolved, within a few years, to a highly developed, compact, powerful and trustworthy means of power, simple in operation, and available at all times to supply the farmer's need for power. While some types of the farm tractor still cling to the large iron wheel, heavily cleated to secure traction, the more advanced models have adopted the endless belt or "caterpillar" means of locomotion. This style of machine, by reason of the distribution of weight and its great traction power, is able to go almost anywhere—through soft mud, up steep hills, and across obstructions that would prove impassable barriers to horses. Accordingly, even though horses are available on the farm there are many occasions when tractors are able to do work impossible for the horses. Many a machine has more than paid for itself in being useful in an emergency, such as finishing plowing under adverse weather conditions, harvesting grain before the advent of a threatened storm, or preventing the spread of a disastrous prairie fire.

An example of the latter occurred last summer on the level lands of the San Joaquin Valley, in California. A 1,000-acre wheat field was ready for cutting and threshing when a grass fire occurred in an adjoining field. The weather was extremely hot, the sun shone out of a clear sky, and as it was in the "dry season" and no rain had fallen for months, the ground was as dry as tinder. With the wind blowing directly toward the grain it looked as though the 1,000-acre field were doomed. The owner, however, was quick-witted, and hastily sending his two tractors to the scene he plowed up a wide path along the side of his ranch, which acted as a firebreak and stopped the fire. With horses alone it would have been wholly impossible to accomplish this result in time. The extreme heat alone would have prevented their doing effective service.

As an example of the unique purposes to which a tractor can be put we have the experience of a land company, near Fresno, Cal., which desired to utilize a large acreage of absolutely virgin land in the growing of Smyrna figs. The land was underlain with hardpan near the surface, and before planting the young trees it was necessary to break up this hardpan to enable the roots to penetrate to the lower water levels. The company planned to set out over one hundred thousand trees, and the task of boring the holes for the dynamite for each tree was a big one. Finally a tractor was equipped with a drilling rig and a special water tank to be operated by the tractor motor and the work was commenced. The driver, from his seat on the machine, with one lever operated the drill which bored through the hardpan, released the required measure of water to clear the hole, raised the drill and cleaned it ready for the next marked spot. Another lever operated the tractor itself, allowing it to move on to the next hole, when the belt was again switched to the drill, and the work continued. A second man followed with the powder, placed the charge in the hole and fired it. So fast did the men work that the explosions occurred at regular intervals and the entire job was completed in record time.

Operating a drill with a tractor in connection with the setting out of fruit trees

As a means of clearing new land the tractor is without a peer. It is able to forge through heavy underbrush that would scratch horses to pieces, and it has the power to pull the plows through the tough sod and root systems. This was demonstrated on the great plains of the Dakotas, where tractors were largely used to break up the virgin ground. It is being done today in many of the Western States, where public lands that remained unoccupied for centuries are now being placed under cultivation. In Nevada the desert is covered with a tough grass that has almost the strength of wire, and in one instance a settler had tried to clear his land with horses but found it almost impossible to make headway. The plow would be caught by this wire-like grass, and the horses could make no headway against it. Finally, he secured a tractor, and the land was quickly cleared, for where the grass could not be cut, the machine pulled it out by the roots.

Where the land to be cultivated has once grown trees, the work of clearing out the stumps and root systems is a laborious one. Here the tractor has demonstrated its usefulness, as in many instances it has been used for this purpose.

On the Yuba River, in California, a large dredging company finds it necessary to clear the lands to be worked by its gold ships. As these lands are all along the Yuba River dense growths of trees and underbrush have grown up. Some of these trees are of large proportions, and the root systems extensive. The dredging superintendent uses a ball-tread tractor in the work of clearing the land, and he has found the machine able to handle almost any kind of a stump encountered. By rigging up a special drum, over which the cables run, the power from the tractor engine is multiplied, and when the cables are attached to the tree to be felled, they are readily pulled down. The roots are either pulled out by the tractor, or dynamited, and not only is the work of clearing the land performed in shorter time but the expense is less than before the tractor was used.

The tractor is being largely used in road work, and many county supervisors and road districts are purchasing tractors for use in keeping roads in good condition. By the use of scrapers, rollers, and other road-making machinery, attached to tractors, it is possible to accomplish more work on roads and at less expense than by the use of horses. In Spokane, Wash., the officials have found tractors useful in cleaning the streets, and during heavy snowfalls, the streets are cleared of snow by the machines.

As a means of transporting heavy material over rough roads or steep grades, the tractor has commended itself to many contractors, mine superintendents, lumbermen, and railroad builders. In building the Los Angeles Aqueduct, where large quantities of supplies and heavy material had to be transported across a wide stretch of hot desert, the tractor was found almost indispensable. Its tracklaying wheels were able to pull a heavy load through the soft sand, it was not subject to the intense heat, and the small amount of fuel it required was easily carried, whereas the horses or mules required large quantities of feed and water, and lost a considerable portion of their energy through the intense heat of the desert. Many mining companies use tractors, instead of trucks, to haul supplies into the mountains, because of the superior traction, and the machines are used to haul ore, logs, railroad supplies, and other merchandise under almost every adverse condition found in the West. Even in the valleys, where motor trucks or horse-driven vehicles are available, owners of tractors find them superior for hauling supplies by reason of the fact that the tractors will pull from three to six heavily loaded wagons or trailers, thus economizing in man-power needed to supervise the transported material. It is a common sight in the grain and rice districts of California to see a train of many heavily loaded wagons coming along a public road, pulled by a single tractor. As the tractors of tracklaying type are not injurious to public roads, they are not prohibited from using them except under certain circumstances.

(Continued on page 300)

Tractor driven from the seat of the spreader which it pulls

Tractor pulling stumps in a California gold-dredging field

A storehouse filled with dried vegetables awaiting shipment

The conveyor that carries the fresh vegetables up to the preparing room

Dehydration Industry in America

How It Is Carried On, and the Place It Holds in Our War Progress

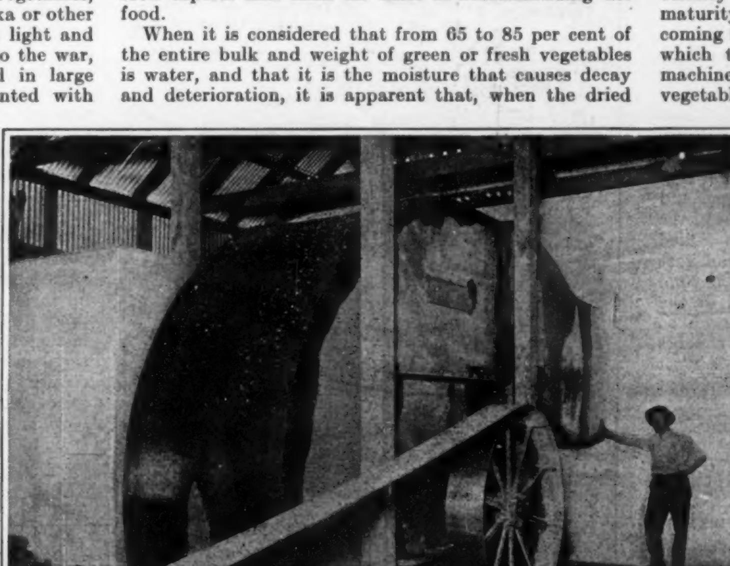
By E. Clemens Horst

FOSTERED by large Government contracts there is developing in this country a new industry that will be of material permanent benefit to our economic life. This industry is the dehydration, or drying, of vegetables. By subjecting fresh vegetables to the action of circulating currents of warm, dry air the moisture content is exhausted with the result that the weight and bulk of the product is greatly reduced and the vegetable is made non-perishable and can be kept indefinitely. The cell structure and the flavor is not injured by the drying process; soaked in water for a few hours, the dehydrated product is restored to its original color, bulk and food qualities and when cooked it has the flavor and appearance of the fresh article.

A year or two ago the dehydration of vegetables in this country was practically unknown. There were one or two small plants engaged in drying berries and vegetables, but the bulk of their output was used in Alaska or other distant places, where food supplies must be light and durable. At the entrance of this country into the war, and when our soldiers began going abroad in large numbers, the War Department was confronted with the task of supplying enormous quantities of food to maintain the United States Army in France, at a time when the demands upon world shipping were the most pressing in the history of the world. To solve the food problem the various departments of the Government coöperated and exhaustive tests were made of the different kinds of food available for export. The advisability of using dried vegetables was suggested, and a hearing on the subject was had before a sub-committee of the Senate Committee on Agriculture and Forestry, at which the food experts of the Department of Agriculture and the Food Commission appeared and testified as to the merits of the food. Representatives of commercial companies engaged in dehydrating vegetables were also heard, and the writer appeared before the Committee and told of his experiments conducted in California. Samples of dried vegetables were exhibited, and hundreds of pounds of the food were distributed throughout Washington to be tested for flavor and food values. The restaurants in the Capitol served various vegetables cooked from dehydrated stock supplied from the California plants, and scores of Senators and Congressmen ate the food and were astonished at the similarity to the fresh. At the Reed Hospital in Washington, 450 men were fed on the dried vegetables, and it was found that five pounds of dried stock supplied ample food for all. The President was even kind enough to try some dried tomatoes, which were made into soup, and many of the officials of the Government tried the samples in their own homes.

As a result of these tests the War Department entered into contracts with several companies possessing the facilities for drying vegetables, and these contracts are being enlarged as the industry develops and can take care of new demands. On the Pacific Coast, one organization alone now operates ten large commercial driers, employing several thousand people, and large acreages have been contracted in the vicinity of the drying plants for the growing of vegetables. Millions of pounds of dried potatoes, carrots, turnips and other varieties have already been shipped to our armies abroad, and a steady stream of the new form of food speeds across the country and the Atlantic to satisfy the appetities of our boys over there. The American Red Cross has also become a large purchaser of dried vegetables for use in its rescue work in the devastated regions, and in this country many of the large charitable institutions are becoming interested in the product for use in their work. The big shipping companies have found dried vegetables particularly adapted for use on ocean vessels, because of the small space required for storage, and the keeping qualities and superior taste over canned goods. Scores of the finest hotels from New York to San Francisco now serve vegetables made from the dehydrated stock, and they report that the food is superior to that made from anything but absolutely fresh produce. Many economies can be practiced by these large institutions in using dried vegetables, because all of the labor of preparing the food is eliminated. There is nothing to discard and no cleaning or washing of the vegetables is necessary, as all of this is done at the drying plant. Dietitians of hospitals and food experts and chefs all unite in recommending the food.

When it is considered that from 65 to 85 per cent of the entire bulk and weight of green or fresh vegetables is water, and that it is the moisture that causes decay and deterioration, it is apparent that, when the dried product is used, a wonderful saving can be effected in transportation, storage and handling. One pound of dried tomatoes or cabbage is equal to 20 pounds of the fresh or canned; one pound of spinach, when dried, is the equivalent of 18 pounds of the fresh, and so on down to potatoes, which have a ratio of one to six. One carton of dehydrated tomatoes, weighing 2¼ pounds, is equivalent to a case of the canned containing two dozen quart cans, the whole weighing 60 pounds. Therefore, in shipping dried vegetables to our soldiers in France, the Government is able to furnish, in one shipload, as much actual food as could be carried in from fifteen to twenty shiploads of canned goods. If we went a bit further and included the weight and bulk of the tin and wooden containers needed for the canned product, we should find a still greater saving, for in every car of canned vegetables the containers alone weigh about 24,000 pounds. While the dried vegetables furnished the Government are put up in tins, they are large enough to hold about ten pounds each, and two tins make up a crate light enough to be handled by one man. The lightness of the dried product also permits vessels to be loaded to full cargo capacity, whereas in the case of heavy canned goods it is often true that the weight capacity of a boat is fully utilized without taking up all of the bulk.



The fan that forces the warm air into the drying room

The reason why so many hotels, hospitals and cafes are using dried vegetables is because of the convenience of the new food. A few cartons or tins of each variety of vegetable can be stored in a small space, and when desired for use the only work involved is to place a few handsful in water to restore the moisture content. Where fresh produce is used, a small army of helpers is required to sort the green stock, discarding wilted parts, tops or roots, and to wash the grit and dirt from the food. Even where the fresh vegetables are kept in refrigerated rooms, the loss through deterioration is excessive, and it is estimated that fully 50 per cent of green vegetables grown are lost before reaching the consumer.

Vegetables used for drying are grown in the immediate vicinity of the drying plants, and are allowed to reach full maturity before picking. Within an hour or so after coming from the field they are sorted and washed, after which they are carried, by endless belts, to various machines which peel, slice or otherwise prepare the vegetables for the drying trays. Wherever possible machines are used instead of hand labor, which insures absolute cleanliness and uniformity. The drying trays are taken to the drying rooms and arranged, one on top of another, with open spaces on all sides so that the warm, dry air circulating throughout the room can come in contact with the food, slowly extracting the moisture without injuring the cell structure or chemical constituents of the product. The air is not allowed to get so hot that the food will be scorched or shriveled, and by a system of distribution the air is kept in constant circulation at a uniform temperature throughout the room. When dried, the trays are taken to the packing room, and the food immediately placed in paper cartons, lined with waxed paper, or in large tin cans. Thus protected, the containers can be shipped to all parts of the world and the food will not be injured by excessive heat or cold.

At the drying plants nothing is permitted to go to waste, for all tops, peelings and waste portions from vegetables are fed to stock or hogs, and even the water used for washing the vegetables is saved and the mineral salts found therein are mixed with the greens fed to hogs.

The expansion of the industry offers tremendous opportunities to this country. With a large commercial plant or a community plant in each locality, a new market will be offered to vegetable growers. Thousands of acres of waste lands in the outskirts of cities, towns and villages can be utilized for the growing of vegetables, and the spaces between fruit trees in orchards can be used for the same purpose. Surplus market stocks can be taken to a nearby drying plant and saved, as is done in Europe. Germany has several thousand drying plants scattered throughout the country in which are dried all surplus vegetables grown, and before the war she annually dried twice as many potatoes as were grown for all purposes in this country. Her dehydrated vegetables have doubtless been one of the reasons why she has been able to withstand the food blockade of the Allies. England, Italy and France are also large users of dried vegetables, and in many communities the law requires that all fresh vegetables left over in markets at the end of the day shall be taken to drying plants. The feasibility of the new industry has been fully demonstrated, and the only thing remaining to be done to cause its rapid expansion is to educate the people to use the new form of food.

Strategic Moves of the War, October 2nd, 1918

By Our Military Expert

British 60-pounders covering an advance by the Canadians, 1,000 yards away

THE history of the great world war has been rapidly made in the past two weeks and on every front of the extended battle lines in France, the Balkans and Palestine. Only Italy and Russia have failed to show great gains for the Allies under the guidance of the central control; even in these two countries military developments may be looked for at any time as long as suitable campaign weather holds until the advent of winter. The surprising successes of the Allies against the Germans in France, against the Bulgarians on the Salonica front, and against the Turks in Palestine, have undoubtedly discouraged the Central Powers as much as they have heartened and encouraged the Entente Allies, who now look forward to ultimate success as a thing assured.

Up to a few days ago the fighting on the Hindenburg lines in the west had been largely local though many of the engagements had taken on the violence of pitched battles. The British army had fastened itself at many points near the lines and all the efforts of the Germans to dislodge them had failed. All the way between Cambrai and St. Quentin this theater had seen a constant succession of attacks that must ultimately lead to breaks at various points, despite the most stubborn and desperate resistance on the part of the Germans, who have made use of trenches, deep ravines, and all natural obstructions where they would have less to fear from tanks or the overwhelming numbers of their adversaries. The latest reports show a British advance toward Cambrai that is the beginning of an ambitious effort to close in on that city. The attacks have progressed satisfactorily everywhere and the much advertised Hindenburg line has been passed in several places. The French have captured St. Quentin farther south; they are continuing the advance toward the LaFère road and are but a short distance from it and from the Oise River directly behind it.

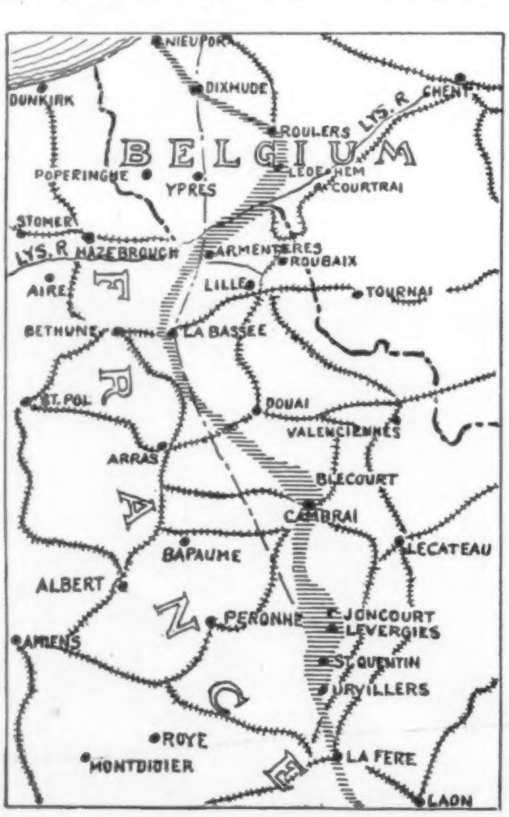
But St. Quentin, Cambrai, and LaFère have in a way become mere outposts of the German defensive lines and have, in the new development, ceased to be hinges of the system of German defenses; for the plan of the Allied commander-in-chief is now in full swing and the vast battle front from the North Sea to Verdun and beyond is all aflame. It is probably the greatest struggle in the world's history; the same tactics that have been so successful in the recent reduction of German salients are continually repeated. The entire situation is most satisfactory and it would seem that the events of the next few days must prove to be most decisive.

On September 27th the combined French and American forces began what is probably one of the greatest Allied efforts of the war on a 40-mile front between Rheims and Verdun; the attack was launched against the Germans on both sides of the Argonne forest in the Champagne and Meuse regions. It took but a short time to break the German lines; in the first day's assault the French drove forward four miles in the Champagne while to the east of the Argonne forest the Americans advanced seven miles as an initial effort. It is evident that the French commander has large objects in view and that his intent is to put a few more dents in the German lines. By driving a few miles north he will cut the first lateral railroad behind the German front, running from the Rheims sector to the Meuse. At Vouziers farther north he would cut another. By moving down the Aisne valley from Vouziers to Rethel he would not only break all connections east and west between the Laon bastion and the Meuse, but he would also come in on the flank of the present German lines on the Aisne, putting them in a salient to be pinched out at Laon.

The present assault here is against the keystone of the German defensive arc in France and is pregnant with wide strategic possibilities. The point of attack selected is no surprise to students of the strategic positions on the western front, for the Champagne and the Argonne offer the greatest opportunities with the minimum loss of men. It will probably develop into one of the greatest battles, for it has evidently been planned on a grand scale. Success here will mean the evacuation by the Germans of all of northern France and probably of a good part of Belgium also. For the Allied move has in view the driving of a wedge through to the line of the Meuse River where the latter touches the Ardennes mountains, near the borders of Belgium.

Such a wedge would have as a base the fortress of Verdun on the east and Rheims on the west; it would split the German armies and would menace all the communications of their forces in Belgium and northern France. It will threaten the entrance into France from Belgium and must result in the withdrawal of the Germans to the line of the Meuse River. If the battle lines move to the relatively level country around Rheims, it is more than probable that the French commander intends to strike for a straight path into Belgium itself. This is more than likely as the abandonment by the Germans of strong positions that had been heretofore constantly strengthened from the time of their first occupation shows a condition of anxiety and nervousness that has led not only to tactical errors but is a confession of weakness that has been unexpected. For they are beginning to realize that it is not the policy of the Allied commander-in-chief to put his trust in one movement; but that it is his intent to destroy the German armies now in France and, while doing so, to drive them back across Belgium and into Germany.

The best way to carry out these designs is the method being followed of everywhere keeping the lines under



The breaks in the Hindenburg Line, October 2nd

The dash line represents the Hindenburg positions, and the broad black zone the location of the fighting on the above date.

pressure and shifting constantly the points and direction of the attacks. Thus the Germans can nowhere create or keep a strategical reserve but must split up such a reserve into parts to be distributed as best possible. In such a case some one part of the line must eventually collapse and thus the whole front will be swept back or entirely destroyed. The attacks upon St. Quentin and Cambrai and the struggles for Laon, LaFère, and Douai are thus seen to be but links with the Meuse valley-Argonne-Champagne operations. This is also the case with the advance of the British and Belgians around Ypres and farther north where unexpected German weakness is displayed; Dixmude and Roulers have been taken and Menin is threatened. By the capture of Roulers, the railroad from Lille to Ostend and Zeebrugge has been cut and it can be a question of only a short time when these two submarine bases will be abandoned by the Germans. These are all attacks on the flanks and center of the German lines, from Nieuport to Mülhausen, and are enabling the Allied commander not only to make continuous use of his forces but also to utilize to the greatest advantage his superiority in men and guns. A gain at one point is felt immediately everywhere along the line and turns what are apparently isolated attempts into a continuous battle with all moves interlocking.

The Germans have attempted to make strong stands at various points; but they have not so far found positions of sufficient strength to be able to offer effective resistance. If the American troops, now advancing on the Meuse, can reach Stenay, they will not only cut the lines to Montmédy, Longwy, and Luxemburg but can also outflank all the lines of communication between Laon and Metz. Such a move will go far to cut all communications between the German armies in France and Belgium and those in Lorraine and Alsace; because north of Stenay, the Ardennes mountains are a bar to quick communucations east and west and farther north there are only long roundabout railway and road connections with Germany via Liège, Aix-la-Chapelle and the towns in the Rhine Valley.

While the Germans probably looked for an attack in the level Champagne country, they hardly expected the drive toward the north along the Meuse that has been made by the American Army, meaning as it did an attack by two wings separated by the wooded Argonne hills. Yet this daring move was carried out, and the Germans in the forest region have no doubt been almost surrounded by the Americans and French who have come up on the west side of the mountains. At any rate, a hasty evacuation of the regions has been or will be found necessary to save losses to the Germans in men and guns. Once this evacuation has taken place and both forces are on the northern edge of the forest, a great success will have been won; for a strong position will have been created from which a drive can be made that will carry the French and Americans on to Rethel and Stenay and to the country around Sédan. And if that can be done, nothing will be left to the Germans but to retreat to the French frontier all the way from Lille to the banks of the Meuse River.

On the St. Mihiel salient the American army has established its line running from the southeast to the northwest across the mouth of the salient and for the time being appears to be resting after its victorious advance. Its position is on the edge of the hills that drain to the east into the valley of the Orne River; in fact the troops are on the edge of the Briey Basin, the possession of which is so vital to Germany's iron and steel industries. The line is only 15 miles back of the great railway from Metz to Mézières that supplies the German armies to the north and west in the Champagne region. The position of the American line gives an excellent opportunity to the French to attack down the valley of the Orne from their commanding positions around Verdun and thus to open the way into the Briey region and to threaten Metz from the west and north. If this were combined with an advance of the American right and of the Second French army around Nancy into Lorraine, Metz would also be threatened from the east and south and thus a gradual investment of the fortress could be made. Already its forts on the west are under the fire of American guns from their present positions in the St. Mihiel salient.

The advance of the Allies in the Balkans has been a most surprising success as the Bulgarian-German armies were quickly driven back, dispirited and discouraged, with the loss of both men and guns. Starting out from their positions between Monastir and the Vardar valley, the Serbians pushed forward some days ago across the mountains and down the valley of the Cerna River, cutting the railway line between Salonica and Uskub. This road was the main line of communication for the Bulgarians and, as a consequence, all their armies were forced to retreat. The French and Serbian forces took Veles, and ten miles south on the Veles-Prilep road they cut off the retreat of the Bulgarian First Army toward the Vardar. This army apparently broke up, for the parts that were trying to retreat through Prilep to Veles would be forced to make a detour over difficult roads and paths to the west through the mountains to Uskub. But the Allied troops were nearer to Uskub, being only 25 miles away; and they also had an easy approach to the town up the Salonica-Uskub railway. Part of this hostile First Army that held the front west of Monastir retreated to Krushevo ten miles west of Prilep. From that point it would have had to push north into the mountains of southern Serbia or go west

(Continued on page 302)

Outstripping Germany in the Chemical Industry

Large-Scale Production by Means of Machinery

By H. E. Howe

AT The Fourth National Exposition of Chemical Industries recently held in New York, the general public demonstrated as much interest in the exhibits as did the professional men. Indeed, one of the important functions of the exhibition since the first one in 1915 has been the spreading of information regarding chemical industry among all those concerned, although many had previously failed to appreciate its importance to them. The place of chemistry in the minds of the authorities is best illustrated by the fact that although other tenants had been required to vacate the building in which the exhibit was held, our government approved the plans for the week and allowed the display with its accompanying program to be completed.

When things changed so radically in 1914 chemistry was found by many who had paid little heed to it to be back of much of our civilization's needs. Because the industry was so new there was obviously a real necessity of bringing together the apparatus manufacturer, those having new materials and producers of refined and intermediate compounds, so that more could be learned about things available. The 1915 exposition was the answer and from a part of a floor then to three floors in the Grand Central Palace in 1918 is one index to the industry's growth.

Those who have watched this growth have seen first a rapid increase in the numbers of exhibitors, second the international tone development, third the awakened interest on the part of those having resources to attract chemical plants to locate in their midst and fourth, the progress of the exhibitors themselves. The increase in the number of exhibitors is but a natural expression of what have been going on. Hundreds of millions are now invested in chemical plants. A single company has expended twenty-five million; another purchases supplies and materials worth from three to five millions each month. The war has created chemical opportunities which have given rise to many new corporations and some of these have already joined their efforts. An international tone has been taken because of the excellence of the work done here and because abroad America is being recognized as a satisfactory resource for an increasing percentage of those materials formerly obtainable only in Europe. South and Central American representatives were to be found in attendance, examining apparatus and discussing problems. The Orient finds the exposition attractive no less than representatives of our European Allies and our neighbors in the western hemisphere, Canada and Mexico.

The Wealth of Raw Materials

Regions of our country blessed with resources affording raw materials for chemical industry display the information attractively and both chemist and banker are beginning to know the opportunities presented in eastern Tennessee, about Knoxville, in Georgia and Ontario. Certain railways have called attention to the regions which they serve and information has been obtainable regarding Canada from representatives of one of the Dominion departments in attendence. The progress of the exhibitors in their special lines has been marked. Materials made only in the laboratory a short time ago are now produced on a commercial basis. Many troubles due to impurities have disappeared as the technique of purification has been mastered. Dyes that were unsatisfactory are now of a superior grade, largely due to improvements in intermediates and increased purity of reagents. The range of all chemical products is broadening and compounds talked about or promised a year ago are now to be found displayed. To emphasize this quite remarkable progress bullseye labels were placed this year on those things now made in America but formerly not manufactured on a commercial scale here. This putting on of flesh by the lean figure of chemical industry is in every case addition to muscle which will give strength for the commercial contest so many expect in post-war days. The coöperation needed between chemical manufacturers to entrench the industry still better and the government assistance to make it bomb-proof show encouraging signs of development.

Upon the layman at least two deep impressions seemed to have been made in addition to a real appreciation of what chemistry has demonstrated itself capable of doing. He was amazed to find nearly 350 exhibitors cataloged and surprised to learn that chemistry, that is industrial chemistry, is very different from what he had supposed any chemistry could be. Many people are convinced that chemistry concerns only obnoxious odors, stained hands, damaged clothing, premature explosions and pretty colors and that it is all conducted by a mysterious man using test tubes or beakers. To such good folks the exposition proved that industrial chemistry requires ingenious, large-scale apparatus the design and construction of which is very often as serious a problem as working out the reaction involved. For instance, those very reactions begun in the laboratory test tube can not be carried out commercially in glass containers and it may be difficult to provide something that will resist the chemical action in hand equally well.

Introduction of Big Machinery Into Chemical Industries

The American method consists in large scale production, made as mechanical as possible to save labor. And that was *the* lesson which the Germans learned when they visited us in 1912 on the occasion of the Eighth International Congress of Applied Chemistry. They found such chemical manufacture as then existed carried on in much larger units than they had ever used and it surprised them to see the perfection of our mechanical devices. They used the information to their advantage; and yet in 1914, they felt sure that lack of both laboratory and commercial appliances would make it nearly impossible for America to displace Germany in the chemical field!

It is out of the question to discuss reactions here, but it may be said that adding acids to toluol to nitrate it to T. N. T., tri-nitro-toluol, is accompanied by more difficulties than a simple statement discloses, including a safety factor, which must enter into machinery design. To meet these conditions a nitrator has been built which is capable of changing the liquors at the rate of 2,000 gallons in 30 seconds, using a propeller device which draws the contents from the bottom of the nitrator to an outside system through which the material is rapidly discharged into the top again. Meanwhile the proper temperature is maintained within by cooling coils provided with litmus paper controls which indicate any leaking of acid to water and there are governors which control the toluol inflow should temperature conditions be incorrect. This apparatus is of great size and represents what has been accomplished in chemical castings.

Acid-proof Ferrous Alloys

Ferrous alloys have been devised such that most acids are ineffective and this is easily demonstrated by running acid from the alloy to ordinary cast iron and noting the change in the color of the acid. Now these castings were to be had in small sizes before the war, but the manufacturers thought large ones could not be cast and lacking an insistant demand nothing was done. All that

(*Continued on page 303*)

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

One of Eleven

To the Editor of the SCIENTIFIC AMERICAN:

Your magazine is one of 11 which the American Library Association has found in such demand in its Library War Service as to warrant a subscription for some 650 copies. These go to 650 service points, including the various Camp Libraries, Y. M. C. A. and K. of C. huts, other recreational centers, and small camps and posts where we supply books and other reading matter.

The Library War Service now reaches 43 large U. S. Camps, where there are central libraries, and more than 1,500 distributing branches and stations; 500 smaller army and navy camps, posts and stations; 143 hospitals; 242 vessels; more than 300 distributing points in Europe.

Men in these camps want each current issue of the SCIENTIFIC AMERICAN, as camp librarians all assure us. In general, copies reaching them under the Burleson "one-cent" privileges have not been of sufficiently recent date, nor in sufficient quantities.

The pleasure a recent number of the SCIENTIFIC AMERICAN will give to a man in camp or in France can best be understood by your readers. Therefore, we hope you will once more remind your readers to put a one-cent stamp on each number *as soon as it has been read*, and drop it into the mail box, under the Burleson provision.

An army of millions of men will need hundreds of thousands of every issue of your magazine.

CARL H. MILAM,
Assistant to the Director,
American Library Association,
Library War Service.

Winning the War

To the Editor of THE SCIENTIFIC AMERICAN:

As an American engineer I want to contribute my bit, to accomplish that end. We are a nation of inventors, while it is not on record that the Germans have ever given to the world any great inventions.

General Pershing asks our Government for jitney tanks for winning the war. In our army and navy are some of the best engineers, mechanics and chemists in the world, who would gladly make all the jitney tanks and other weapons of war if given the opportunity right on the ground behind the battle lines.

Complete plants can be mobile so they can follow up our soldiers even to the gates of Berlin. This is made possible by modern inventions. For example, the man in the forge shop will contribute more to our final victory than any other branch of industry. Heretofore forge shops have had large drop or steam hammers with great foundations which cost nearly as much as the hammer itself. Thanks to our American and British engineers, today a complete forging plant can now be installed or mounted on a flat car consisting of one steam hydraulic forging press, with jib crane, oil-fired boiler and heating furnace. This forging plant is capable of handling and forging 6- and 7-inch square billets into any shapes, such as are common to work in the average forge shops. This forging press has double the capacity of a 1,500-pound steam hammer; it needs no foundation and when erected on a car, it can follow up our victorious troops and supply their immediate wants on the ground. Smaller forging plants can be installed in the same manner. Lathes, planers and all other machine tools, together with assembling plants can thus be erected on flat cars, which are protected from the elements and airplanes. This system would place us in a position to repair everything right on the ground; give our engineers and inventors a chance to perfect new weapons of war to assist our soldiers in clearing up the road to Berlin, and save millions of dollars to our Government. It would also furnish congenial employment to our convalescent engineers, mechanics and chemists.

This is a war of steel and has made steel one of our most precious metals. The production of both steel and munitions is limited by our ability quickly to expand coal production. It requires from four to five tons of coal to produce one ton of finished steel. It is stated, that during the battle at Verdun, the French fired from their cannons 60,000,000 shells containing 1,800,000 tons of steel, the production of which consumed nearly 9,000,000 tons of coal. One 3-inch shell takes 20 pounds of steel and 80 pounds of coal.

Mr. Leonard Replogle, Director of Steel Production, stated recently that our Government requirements for steel covering the last six months of this year will reach 21,000,000 tons, while the present prospects for production during the same period is only 16,000,000 tons. The steel mills are not running to their full capacity until they can get more coke. More coke in turn, depends upon more coal.

This condition of the production of steel opens up a vast and prolific field for our American engineers and inventors to shorten the duration of the war and clear the road to Berlin. Great improvements have been made in the electric furnace for the production of steel of a superior quality, from scrap, properly selected. The battlefields of France can furnish thousands of tons of scrap steel and the rivers and water courses of France can furnish the electricity in thousands of H. P., thus solving the coal problem.

An electric furnace with our present-day knowledge can be installed on a flat car, made mobile so as to follow up our battle line on the road to Berlin.

The above is a synopsis of a perfect system, up-to-date in every particular, and if adopted by our Government would insure us a speedy victory; solve the coal problem; ease up on our shipping; give our engineers an opportunity to invent new war weapons; furnish pleasant employment to our convalescent wounded heroes; supply army wants at the front; save millions of dollars to our Government; help home industries; chase the Huns to Berlin and then to Hades; end the war and bring peace to the world.

JAMES FRANKLIN DUFFY, M. E.
Chicago, Ill.

"Who Shall Eat the Bran?"

To the Editor of the SCIENTIFIC AMERICAN:

Mr. Vaughan, who criticizes my article upon the utilization of wheat bran, has evidently mistaken the purposes of this article, which was merely to point out that in considering the use of wheat bran as human food many factors must be taken into consideration. One of these factors, the value of the mineral constituents for fertilizing purposes, is rarely given much, if any, consideration. It seems to me that this point should receive consideration, especially at a time when the fertilizer situation is so critical. As to Mr. Vaughan's criticisms, it seems to me that in a number of instances it would be difficult for him to submit sufficient data to substantiate the statements which he has made.

A. D. HOLMES,
Specialist in Charge of Digestion Experiments.
U. S. Department of Agriculture.

How to Get Paper

THE Mexican Government has experienced all kinds of difficulty, in view of the restrictions put by the United States upon the shipment of paper, in getting the material for newspapers and official documents. It has accordingly placed on the import of paper a "duty in kind," but which looks like confiscation. On newsprint paper this duty amounts to 30 per cent and on other grades 20 per cent. Payment in paper is exacted.

This enormous engine, the largest ever built, weighing 449 tons (of 2,000 pounds),

"Most Powerful Locomotive in the World"

Its Cylinders Are as Large as the Locomotive Boilers of 50 Years Ago

SO rapid and unending is the increase in size of engineering constructions, that no careful prophet ventures to predict that we have reached, or are even approaching, the limit. Otherwise, we might venture the statement that, in the mammoth locomotive which sketches across these two pages, the limit has at last been reached.

Certainly the boiler, 9 feet 4⅞ inches in diameter, can go no higher. It is already level with the top of the cab; the smokestack has shrunk to a mere ring; and the sand boxes have been crowded from their immemorial position of dignity astride the boiler and forced to cling snugly against its side.

If the future "mammoth" can go no higher, it certainly cannot spread out to the sides; as a glance at the castings containing the two 48-inch cylinders will show; and as for length, an engine with its tender that measures 105 feet over all has surely reached the limit.

This Mallet locomotive, with a tractive power of 147,200 pounds, working compound, and 176,600 pounds, working simple, is one of ten which are now being delivered to the Virginian Railway by the American Locomotive Company. They are being built to the order of the authorities of the Virginian Railway, who have the problem of handling a constantly-increasing volume of traffic on an exceptionally difficult part of the system.

The portion of the line between Elmore and Clark's Gap on the Deepwater division, a distance of about fourteen miles, has a grade for the last eleven and one-half miles of 2.07 per cent, with maximum compensated curves of 12 degrees. For the first two and one-half miles the grade is 0.5 per cent. This fourteen miles is all single track and includes five tunnels, which compel the use of an absolute block. This is the crucial part of the entire system, as all the tonnage of the Virginian Railway passes over it. During the last eleven years Mallet locomotives have been employed in handling this traffic. The size and power of these locomotives have progressively advanced to keep pace with the growth in volume of traffic.

The first installment consisted of four engines of the 2-6-6-0 type with tractive power of 70,800 pounds. Next in sequence were eight of the same wheel arrangement, but with a tractive power of 90,000 pounds. The third installment consisted of one engine of the 2-8-8-2 type with a tractive power of 100,800 pounds. The fourth lot was six engines of the 2-8-8-2 type with a tractive power of 115,000 pounds.

At present, trains passing over the mountain section are operated by one 2-6-6-0 type Mallet road engine, with a tractive power of 90,000 pounds, at the head and two 2-8-8-2 Mallet pusher engines, with a tractive power of 115,000 pounds each behind. The maximum tractive power which can thus be applied to a train is 320,000 pounds, which enables them to handle 4,500 tons in 60 cars having an average weight for car and load of 75 tons.

The traffic volume is still growing, and as the track is single, and as it is not desired to increase the number of engines on any train above three, it has been found necessary to put still larger locomotives into service. The enormous locomotives under discussion were developed in order to accomplish this result.

Upon receipt of these new engines, trains will be composed of one of the 2-8-8-2 Mallet engines, having a tractive power of 115,000 pounds, at the head and two of the new 2-10-10-2 Mallet engines, having a tractive power of 147,200 pounds, behind, giving a total tractive power for the train of 409,400 pounds. This train will have a tonnage of 5,850 tons, the equivalent of 78 cars having an average weight for car and load of 75 tons.

The 2-8-8-2 type Mallets, which will be used on the head end of the train, were built by the American Locomotive Company in 1912 and 1913. At that time these engines were the most powerful locomotives in the world. The following comparison shows the extent in which these 2-8-8-2 type engines were exceeded in the new 2-10-10-2 type:

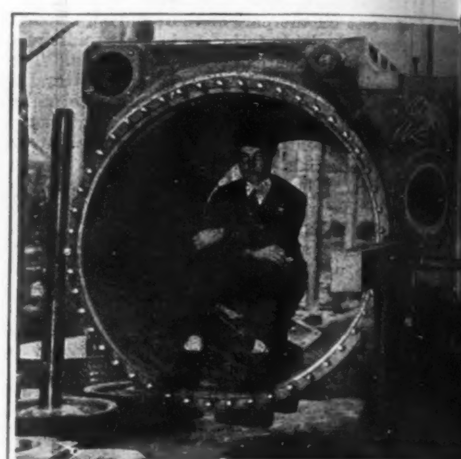
	2-8-8-2 type	2-10-10-2 type	% increase
Total weight of engine, pounds	540,000	684,000	26.6
Total weight, engine and tender, pounds	752,000	898,300	19.5
Heating surface, sq. ft.	6,909	8,606	24.5
Superheating surface, sq. ft.	1,311	2,120	61.7
Tractive power, compound pounds	115,000	147,200	28
Tractive power, simple, pounds.	138,000	176,600	28

Apart from the enormous weight and power of the locomotive as a whole, some of the dimensions of the boiler are impressive as showing the extent with which all limits were exceeded in its design and construction. At the first course it is 105½ in. diameter outside, while the outside diameter of the largest course is 112⅞ inches. The barrel is fitted with 381 tubes 2¼ inches in diameter, and 70 flues, 5½ inches in diameter and 25 feet long. A combustion chamber 36 inches long is included. The firebox is 181¼ inches long and 108$\frac{3}{16}$ inches wide. A total heating surface of 8,605 sq. ft. and a superheating surface of 2,120 sq. ft. are obtained.

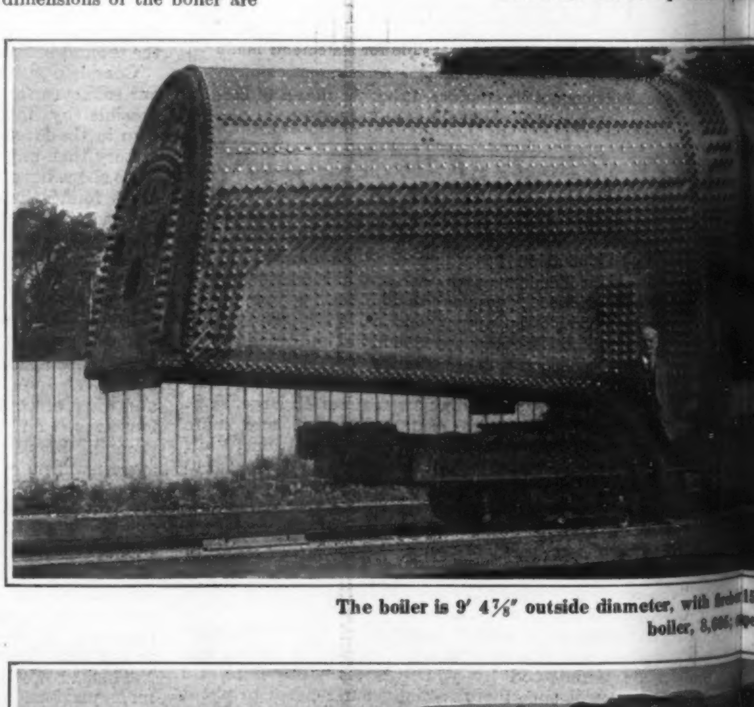
The engines may be worked as simple (in starting) or compound. The pair of simple engines, 30 inches in diameter by 32 inches stroke are carried in the main engine frame; the pair of compound cylinders, 48 inches diameter by 32 inches stroke, are mounted with the leading pair of wheels and the ten 5-coupled drivers as a separate unit, the forward half of the boiler resting upon this unit which is free to move laterally with respect to the boiler in rounding curves. The boiler pressure is 215 pounds to the square inch.

The tender carries 12 tons of coal and 13,000 gallons of water. The consumption of coal is 6½ tons per hour, and it is fed to the furnace by a mechanical stoker.

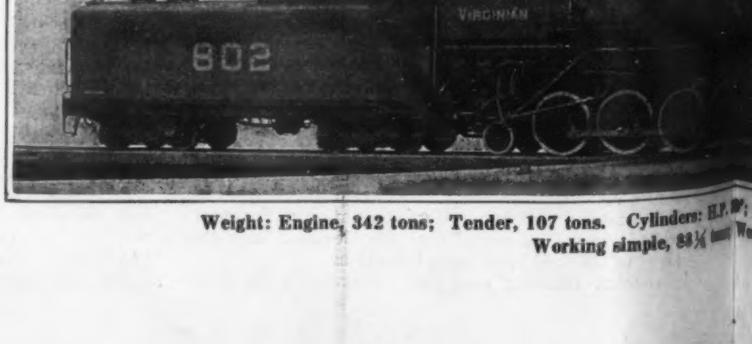
The horse-power, when the engine is exerting its maximum effort is 5,040, which is approximately equal to the combined horse-power of four of the 3,500 fabricated cargo ships



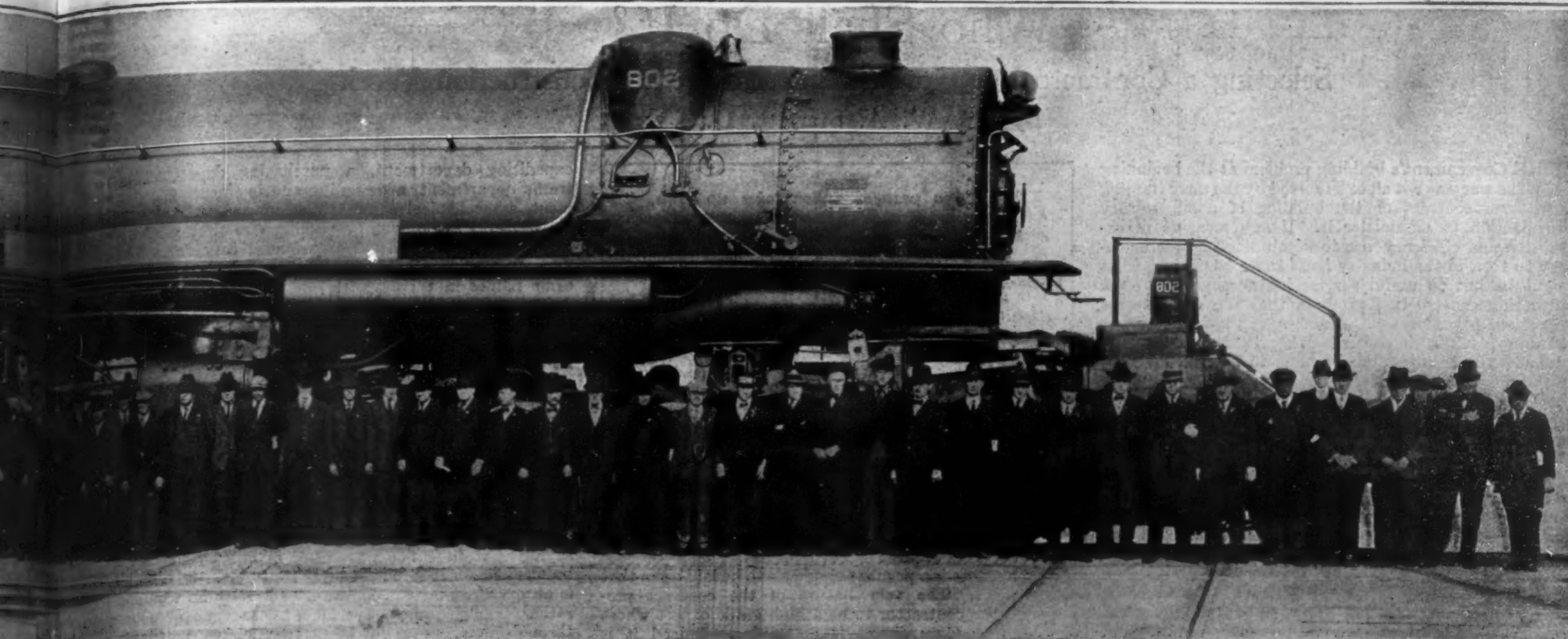
These are the low-pressure cylinders, 4



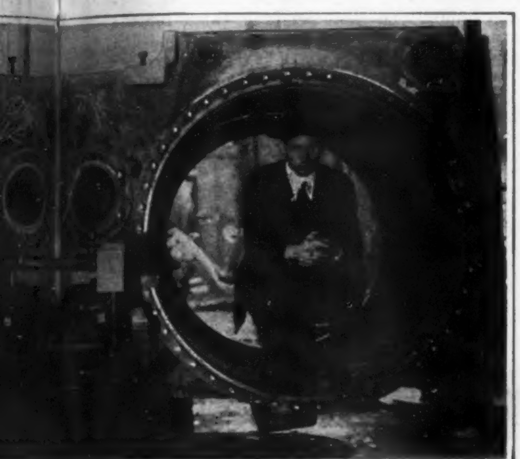
The boiler is 9' 4⅞" outside diameter, with firebox 15' 1
boiler, 8,606; superhea



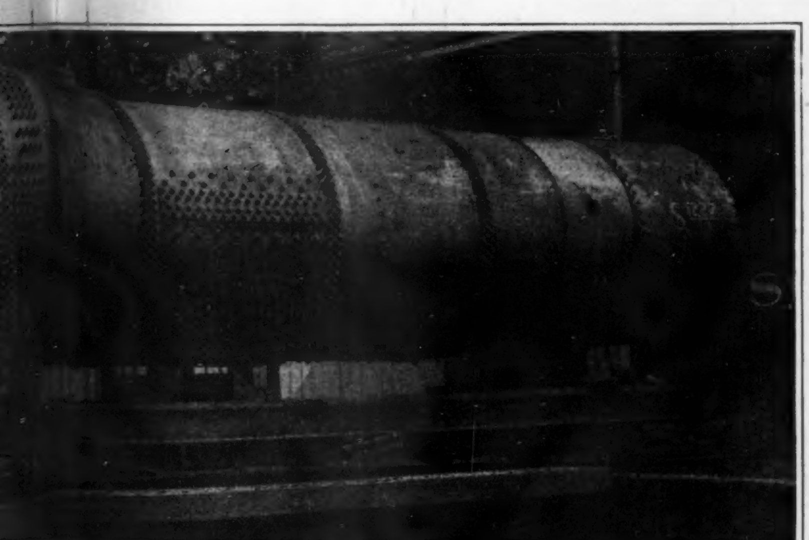
Weight: Engine, 342 tons; Tender, 107 tons. Cylinders: H.P. 30"; L.
Working simple, 88¼ tons Working



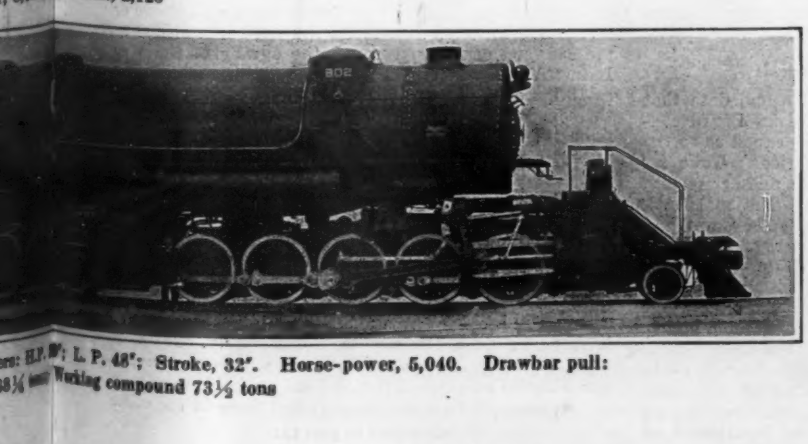
f 2,000 pounds), is 105 feet in length, and is capable of developing 5,040 horse-power



ssure cylinders, 48" diameter and 32" stroke



ith firebox 11' 1 1/16" by 9' 0¼", square feet of heating surface:
, 8,605; superheater, 2,120



ers: H.P. 30"; L. P. 48"; Stroke, 32". Horse-power, 5,040. Drawbar pull:
3½ Working compound 73½ tons

which are being built for the United States Shipping Board.

The design as a whole follows the builder's ordinary practice, differing from previous designs only in modifications made necessary by the increased power. The engines were built at Schenectady, N. Y., and the contract called for delivery completely erected and ready for service on Virginian Railway Company tracks. The shipping arrangement required considerable planning before the railroad carriers could be convinced that they could safely accept and move via their lines, locomotives of such size and weight.

In preparing for shipment of large locomotives it is first necessary to submit diagrams showing the estimated height and width clearance dimensions, and the distribution of weights on each axle to the operating or engineering department of each carrier over whose line it is intended to route the shipment, this in order to secure their agreement to handle the shipment when offered to their line. If some projection exceeds the carrier's clearance limitations, an effort is made to meet the objection by removing that part, if possible, and reapplying it on arrival at destination. Or, if the weights are too heavy for some trestle or bridge via a natural route, an effort is made to find a way to ship via a detour route.

These large locomotives presented an unusual problem. It was impossible to ship them completely assembled and moving dead on their own wheels. After the consideration of many plans, it was finally decided to leave the boiler on the frames but trimmed of all outside parts and projections. The cab, low-pressure cylinders, and other certain parts were removed and the remaining skeleton with tender was shipped on their own wheels. Each locomotive required one flat car, one gondola, and one box car to carry the loose and detached parts.

Authority was eventually secured for shipping in this manner although under special operating instructions and via detour routes.

The full route used was as follows:

New York Central Railroad, Schenectady to Newberry Jct.

Pennsylvania Railroad, via Columbia, Perryville, Newark, Del., Porter, Delmar and Cape Charles.

Float from Cape Charles to Port Norfolk, Va.

N. & P. B. L. Ry., Norfolk & Western, and Virginian Railway to Princeton, W. Va.

The Norfolk & Western Railway was used only in the Norfolk district, as the Norfolk & Portsmouth Belt Line Railway could not handle the engines direct to their point of connection with the Virginian Railway.

The engines could only be handled one at a time from Cape Charles to Norfolk as there was only one float—the latest one built—capable of handling the bulky shipment under special instructions.

Each locomotive was accompanied by a messenger who had sleeping quarters fitted up in the cab which was loaded on a flat car. Approximately two weeks was the actual running time from Schenectady, N. Y., to Princeton, W. Va.

Good Milk With Cows 10,000 Miles Away

HOW good milk can be obtained without the dependence on cows is an interesting suggestion. It is claimed that the demand for good milk and cream may be met without the presence of cows, provided transportation, water and power are available. A prominent American chemist offers the following interesting recital.

First of all, let us recall that copra is an article of commerce and consists of the dried meats of cocoanuts. It contains from fifty per cent to sixty-three per cent of oil. There is hardly any limit to the amount that may be produced.

In India, Cochin China, the South Sea Islands and elsewhere the oil has been used as food since the dawn of history, for the fats contained in it are singularly like the milk fats of mammals in most respects. It is already in wide use in this country as "nut margarine" which is cocoanut oil into which some butter has been melted and the whole churned with skim milk, and worked as ordinary butter.

Now let us discuss skim milk for a minute. That is milk with the fats removed. There remain behind among other things nearly all the casein, most of the milk sugar and part of the vitamines, dependent upon the method of drying. Vitamines are reported to be needful to make children grow, in the place of the spankings recommended by Uncle Remus. Casein is the most easily assimilated of all proteid foods.

The process which we are about to describe was patented but not worked out to a commercial scale. The rights were bought by some Chicago business men and when industrial research was necessary, they came to us. The new art consists in mixing skim milk in water and incorporating cocoanut oil with it until it becomes an emulsion just like milk or cream. It is not so simple as it looks, because one can shake up skim milk and cocoanut oil with water until the cows come home, but as soon as the mixture is allowed to stand the oil and water separate.

The striking feature of the invention is the discovery of a stabilizer, a protective colloid, a perfectly harmless body, found in raw sugar, which will make those minute particles of fat shy away from each other just as they do in milk, instead of merging together into one mass, as particles of fat will do under ordinary circumstances.

The process fortunately lent itself to technical development, and all sorts of apparatus were tested out until finally it was ready for commercial scale manufacture. Then we found a purchaser and built a factory which is now in regular operation.

We can get whatever type is wanted; thin milk, rich milk, half cream, full cream, or even thick, clotted Devonshire cream. It tastes like milk and cream, contains substantially the same bodies, is slightly more digestible than the original cow product, while its keeping qualities are fully as good if not better. It is already in successful use at table, in making cream caramels and ice cream, and in cooking.

It may be produced wherever there are shipping facilities, good water and fuel. No cow is needed for 10,000 miles. In the tropics, where milch cows are difficult to maintain; in camps, in industrial centers built on arid land or on shipboard, such an emulsion plant may be set up. It is also in great cities where, owing to the complexities of distribution the price of milk is getting clear out of its proper proportion in the cost of living, that this innovation should be a special boon. The thousands of years' successful use of the same fat for edible purposes, the sterilization of the skim milk by evaporation, the economy of the process and the cleanly methods of preparation from start to finish, all assure the product to be at once wholesome and free from the hazards of commercial milk.

Who Shall Do It?

Selecting a Contractor for Government Emergency Construction Work

By Col. W. A. Starrett, U. S. A.

WHEN a peaceful nation takes up arms, it must put through as emergency measures much of the work to which its bellicose neighbor has been devoting decades of quiet preparation. Before an army can be trained or equipped or transported into battle, an incredible area of vacant land must be transformed into factories and cantonments and supply depots and buildings of every imaginable description. This work must be placed in the hands of those who can do it in record time, and do it right on the first attempt. There is no time to build up organizations, no time to draw lessons from failures; the delays thus incurred would be fatal. How can the nation put its finger unerringly upon the right men and the right organizations?—this is the question which Col. Starrett asks and answers in his fourth and last article.—EDITOR.

THE Government's building problem at the beginning of the war was not all to be solved by the mere framing of a form contract or the building of a supervisory organization to administer it. If any measure of expedition and efficiency was to be obtained it was necessary to turn to the industry itself to ascertain just what might be put to useful service in the solution of the staggering construction program that the Government was about to undertake. A survey of the industry was necessary, for it had been determined by the War Industries Board that the problem to be met could be solved only by using a certain form of contract that left the Government free to make its decisions as it went along, at the same time availing itself of the organized skill of the contractor, under the administration of a strong government supervisory organization.

The first question as to who might be fully qualified to do this work immediately brought up the names of a dozen nationally known concerns whose records of performance entitled them to first consideration. It was seen by the War Industries Board, however, that any such offhand conclusions in the matter would inevitably lead to the question as to what steps had been taken to insure consideration being given to all of the good concerns in the country. Moreover, it was seen that in no department of the Government could be found tabulated information that would give any adequate idea of the full extent of the building industry. Therefore, unless a comprehensive survey were made, concerns of fine organization and ability might be overlooked, simply because no one in the Government connected with the Government's building program happened to be acquainted with them. To meet this situation a canvass of the industry was ordered by the War Industries Board (then the General Munitions Board) as a prerequisite to starting any construction work.

Who's Who in American Contractors

A confidential questionnaire was addressed to the leading architects, engineers and executives of great industrial corporations, which was intended to adduce all possible information concerning the contractors of their acquaintance. The American Institute of Architects and the American Society of Civil Engineers rendered valuable service in the distribution of these questionnaires and, as a result, within two weeks after sending them out, the Government was in possession of fresh first-hand information concerning over fifteen hundred contractors from all over the United States. To the firms whose names were thus obtained another questionnaire was sent asking them to state fully their business experience, the personnel of their going organization, their volume of business including a list of the contracts they had performed since January 1st, 1915, and their financial strength.

But that was not all. It had to be pretty fully understood just what the Government's needs would be, and the solution had to be freed of as many hazards as it was possible to eliminate. It was well recognized that the limited fee form of contract would tempt many an adventurer into the building business, and that the wily charms of these sweet singers would be immediately presented to the Government, generally backed by powerful influence. Such "experts" always minimize the difficulties of the problem and deprecate the skill and knowledge that the substantial element in the industry has acquired through long years of painstaking application; it was therefore important to have information covering the whole record of the contractors who might come under consideration.

The form in which the questionnaires were drawn brought the War Industries Board much of what it wanted and, within a very short time after the survey was launched, the Board was in a position to inform the Government as to the country's most capable contractors, based not only upon what the architects and engineers had said but also upon what the contractors had said about themselves. It is interesting to note that since the early beginning, the information has continued to come in almost without interruption and the files have been amplified and augmented until today they contain live information concerning over thirty-five hundred contractors, most of it very complete and all of it addressed to the question of the integrity, the business ability and the going organizations of the contractors of this country. Such files must necessarily be large and the information varied, but it is through this intimate knowledge of the industry that the Government essays to get the best for itself, at the same time upholding the industry to the greatest extent possible under the circumstances.

The Government and the Contractor

The question will always arise as to just what constitutes a good contractor for the Government, and the answer may be long or short according to the point of view from which it is asked. Asked by the Government in view of its enormous and vastly complex building program, the answer has to be made by taking into account many aspects of the case that may not occur to the casual observer. In the first place a very complete understanding of the emergency form of contract must always be kept uppermost. Integrity is always a desirable thing in any contract, but in the case of our war work there is a peculiar emphasis to be laid upon that requirement. The very nature of the contract presupposes the contractor to be a high grade expert whose services the Government is employing. Indeed it is more accurate to consider him not as a contractor at all but as an organized specialist, fitted by experience and training to do for the Government what it cannot do for itself. He performs the executive part of getting these great operations through with dispatch; he brings to the service of the Government all of the diverse forces that for years the industry has been developing and dealing with. Organization—skillful, resourceful, experienced organization—is the great asset of the contractor; and where it is properly employed under the direction of our experienced constructing quartermasters, the results obtained are a startling confirmation of the wisdom of the policy under which this great building program has been conducted.

To be used properly, the contractor's file must be the subject of constant study; but the files alone will not give the answer to the problem. The organization of the Construction Division must be known and studied, and both of these must be carefully compared and matched up in the light of the operation under consideration. The Construction Division is made up of individuals as diverse in their talents and abilities as the contractors themselves, so it is important to know something of the administrative forces the Government is to put on the work when the question as to what contractor is to be used is to be answered. For example, we have a great concern that has successfully finished a cantonment under the able supervision of one of our best constructing quartermasters. The Chief of the Construction Division has decided to assign this supervisor to one of the Government's great terminal projects. Such a transfer implies the transfer of the constructing quartermaster's whole administrative organization of inspectors, clerks, checkers, accountants, etc.—perhaps a hundred or more people. What is more rational than that the Government shall use again the resources of that excellent contracting organization that has served it so well? In fact the Government would be woefully negligent if it did not take advantage of the experience it has just passed through, for the amounts at stake are literally millions if the dollars alone are to be counted. But after all, time is the essence of the whole question; days, weeks, and even months are saved by these efficient moves. When this is combined with actual dollars and cents economy the question ceases to be ground for argument.

Economy is properly the watchword of the war, but economy does not always express itself in dollars. Time in this war is the true common denominator and, when the question arises as to which must be sacrificed, time must always be given first place. The great administrative problem in Washington is to conserve both to the fullest extent and, therefore, in the case of using the efficient contractor we are observing the approach to the goal of efficiency toward which the whole Government is striving. This question of time is peculiarly an important one when building is being considered, for it must be remembered that our building program must always precede war preparation.

What the Questionnaire Reveals

Out of this great mass of information and data that the contractors' file of the War Industries Board contains there is much information to be gleaned as to the efficiency of the contractors' organizations. Take for example a going contractor in a small middle western town. You may be sure that the First National Bank speaks well of him. So do the Chamber of Commerce and a dozen leading citizens. Their letters all look alike. They have all known him since he was a boy; the bank is unstinted in giving him limitless credit, particularly in view of the fact that the Government pays the whole cost of the operation. But it is well to examine him in detail.

His questionnaire credits him with experience in every line of contracting from railroad building to pneumatic caissons. Then we turn to his organization. Every space is filled out. Yes, he has a financial department, an expediting department, a purchasing department, a traffic department, a designing and engineering department, a mechanical engineering department, a drafting department, and about everything else that goes with the most substantial and experienced concerns. Then we examine closer and find the frequent recurrence of the same names in these various and varied departments. As a matter of fact, generally two to four people are the sum total of the organization. The versatile actor that successively plays the parts of little Eva, the bloodhounds and the cake of ice, or the handy musician that can double on wind and string, have their counterparts in these all-around contractors' employees. A close examination generally discloses the financial man to be the bookkeeper who also keeps the accounts for the town coal yard at night, and the traffic man to be the freight agent who has it all arranged to go in with this excellent contractor as soon as he lands a Government job.

Now, there is nothing invidious in the Government's saying that it is not warranted in entrusting to that builder one of its important war contracts. The builder is an excellent man in his way. Literally he would die rather than see the Government lose time or money through his agency; but he utterly fails to see that his dying in no way helps matters, that by the very fact of his limited prior experience it is not proper for the Government in this crisis to entrust its affairs of magnitude to his hands. In fact the only thing for the Government to do is to bring to the operation in question an organization of tried ability, that has teamed together on works of size and importance, that has a traditional method of doing business on modern lines, and that can start immediately on the operation in question without waiting to build up forces around the good intentions of a worthy but small concern.

The Distribution of Contracts

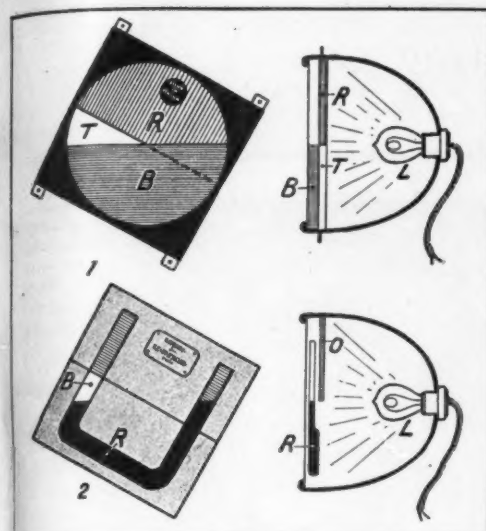
If we keep constantly before us the trilogy upon which the Government's emergency construction program is built—the emergency contract, the Construction Division as administrators, and the efficient experienced contracting organization, all reasoning on the subject becomes simplified. The fact that after all the Government's problem is not to get jobs for contractors but to get for itself the best and most effective service available, makes the examination of the question much simpler than it first appears. After the Government's interests have been served it is proper to view the interest of the industry. It is a great and important one, and one of which the whole country can be justly proud. The equitable distribution of the work, all other things being equal, is an important responsibility that rests upon the Government officials charged with this work and it is one that is not carried lightly. Constant study to determine which are the able, well organized concerns has enabled the Government to undertake a wide distribution of the work. Of a total of 283 recommendations made up to September 1st, 1918, 9 contractors were recommended four times, 14 three times, 39 twice, and the balance of 127 were scattering recommendations.

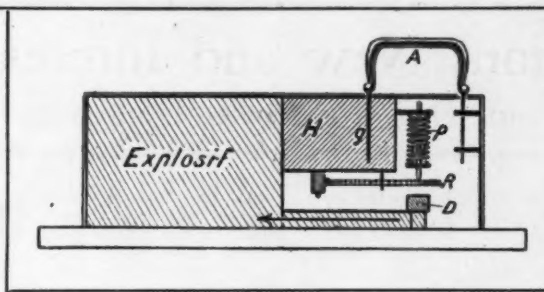
The files have been indexed and cross referenced geographically and, when a job comes up in any given locality, reference is immediately made to the index of contractors of that locality. If there are several good concerns there, a careful study of their relative performances is made together with an analysis of their organizations and going business; all in the light of the Government's own organization and its particular needs on that job. Under the circumstances there is generally one concern preëminently fitted to do the work, all things considered, and recommendation is made for that concern. If the locality does not contain a concern of necessary qualifications, recourse is had to the lists of contiguous territory. Under this method of allocation of contracts it is surprising how near contracting firms come to choosing themselves. It is sometimes true that on the great operations such as the cantonments or the army-base supply depots, contractors from distant points have to be brought in because of their special equipment both as to organization and plant; but generally speaking, every region has within it one or more good concerns able to do the work to which they are assigned and it is through the agency of the War Industries Board's survey that they are brought to the attention of the Government. It is to be observed that there is nothing new in this method of procedure. It finds its precedent in the peace-time conduct of the industry from time immemorial. In fact it is simply applying on a large scale and systematically a process that private industry has used in its peace-time building.

Recommendation and Action

The body charged with this important work of allocating contracts should properly be held to strict accountability for its acts, and one naturally inquires what safeguards are thrown about its activities to prevent it from acting arbitrarily or unreasonably. Again it must be borne in mind that this is all a war activity, not designed for peace times, and one having in mind only economy of time and money, and these in the order

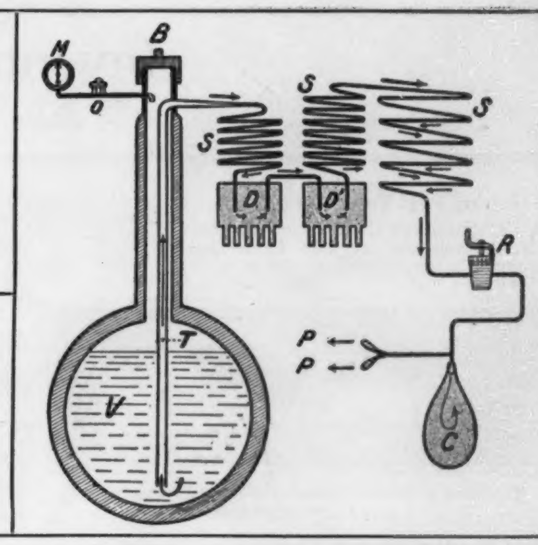
(Continued on page 303)





Some of the ingenious instruments of enemy airplanes

The first instrument is an ingenious lateral stability indicator, as is also the second. Both make use of liquid which always maintains a horizontal level, irrespective of the angle of the airplane. The third apparatus, appearing directly above, is a "destroyer," or an infernal machine intended to shatter an airplane so as to prevent its capture intact by the enemy in the case of forced landings. The fourth is an oxygen apparatus used by German airmen when flying at great altitudes.



Some Tools of the German Airmen

WHATEVER may be the merits of German airplanes as fighting machines, there is no denying the fact that they are thoroughly and efficiently equipped. It is equally true that some of the equipment is superfluous; and that is typical of German effort, which is often at its best when concerned with such details.

Among the instruments found on recently-captured German airplanes are several forms of lateral stability indicators. Two of these are illustrated in the first of the above sketches. The first indicator consists of a semi-circular disk of translucent red glass, *R;* a semi-circular disk of clear, white glass, *T;* a quantity of blue liquid, *B;* and an electric light, *L.* The operation of this indicator is practically self-explanatory: when the wings of the airplane incline either to the right or to the left, the liquid, by remaining horizontal, indicates the lateral angle.

The second indicator is even simpler than the first. It comprises a U-tube, *B,* filled with a red liquid, *R,* placed in front of a translucent glass background, *O,* as shown. Thus any change in the lateral stability of the airplane is indicated by the rise of the liquid in either leg of the U-tube. Part of the U-tube is left clear so as to show plainly by the rays of the electric lamp, *L.*

Indicators of the types just described are employed on long-distance night bombers and patroling planes, and on giant craft, or under conditions where the pilot cannot immediately determine his lateral stability. In the case of scout planes and day machines such apparatus is unnecessary.

To prevent their craft from falling intact into enemy hands, some German airplanes are provided with what might be called a "destroyer," for want of a better name. This apparatus is shown in the second sketch. It is reported that for over a year the two-seater German planes have been equipped with "destroyers." By referring to the sketch, it will be noted that this device consists of a handle, *A;* a pin, *g,* which normally prevents the clock mechanism, *H,* from operating; a gear disk, *R,* which is rotated by the clockwork and which requires ten minutes to make a complete revolution; a firing pin, *P,* which is normally held in place and against the pressure of its spring by the disk *R,* until such time as an opening in disk *R* comes in line with it, permitting the firing pin to drop onto detonator *D,* which explodes the charge. When compelled to land, the German

(Continued on page 304)

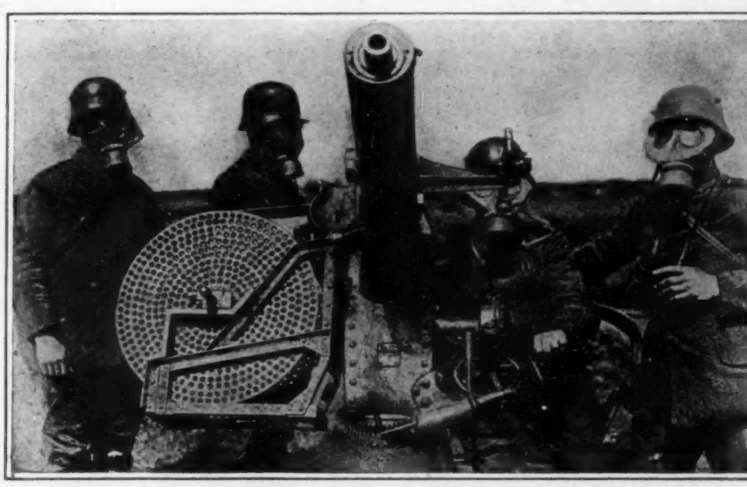
Have the Germans Developed a Practical Super Machine Gun?

AGAIN the "kolossal" tendencies of the enemy have got the better of him. This time it is a super machine gun, which, according to recent reports, is being employed in fair numbers against Allied aircraft in particular.

Despite the numerous mechanical difficulties in the way of developing a belt-fed gun of large caliber, it appears that the Germans have succeeded in perfecting a 1½-inch machine gun. According to the accompanying illustration of such a gun, the enemy's super machine gun is of the water-cooled, belt-fed type. The ammunition is held in a flexible metal or fabric belt, which, in turn, is held on a huge metal reel provided with large handles. This reel is placed in a suitable framework on the right side of the gun, with the belt leading to the gun mechanism.

In maneuvering, the gun is trained on the target by means of handwheels, as shown. Still another interesting feature is the simple form of sights; it appears that ordinary points are used at the left of the gun.

It is a safe guess that this quick-firing cannon is used in conjunction with some form of small shrapnel shell for the purpose of sprinkling the skies during hostile air raids. Due to the high firing rate, it is not necessary to employ the usual delicate sights.



Gas-masked crew of German super machine gun, ready to fire on Allied aircraft

The Lightweight or "Renault" Tank of the French

WHEN the tanks first appeared in battle, it was predicted that they would soon develop into huge forts on wheels. Indeed, many writers did not hesitate to predict giant tanks, armed with large cannon, crashing and smashing their way through all forms of present-day military defenses. But the fact remains that the tank idea has developed along entirely different lines; instead of becoming larger, the tanks have become smaller.

Working on the theory that a tank must present a minimum mark to enemy guns, be capable of operating over shell-torn terrain, and be sufficiently speedy to keep up with its own infantry and with the fleeing enemy, the British were the first to introduce their small, fast tanks, known as the "Whippets." This type has been described and illustrated in these columns. At present, however, details have been made available concerning the small and speedy French tank known as the "Renault" type, which is a counterpart of the British "Whippet."

The "Renault" tank first appeared in battle during the German attacks last June, and like the larger tanks of the French it proved successful from the start. Its outward appearance is bizarre, to be sure; yet when analyzed it reveals simply a pair of caterpillar belts, a body, and a revolving turret. The "Renault" tank is armed either with a machine gun or with a 37-millimeter (1½-inch) quick-firing cannon. During an attack both kinds of armament are employed, the former against infantry and artillery crews, and the latter against machine-gun nests.

The crew of this diminutive tank consists of two, one the driver, who sits in front, and the other the gunner, who sits or stands up in the revolving turret above. The turret with its gun can be turned in any direction. In order to protect the crew from a chance explosion or conflagration of the fuel tank, the power plant is placed at the rear of the body, in a separate compartment.

As for the military value of the "Renault" tank, it is reported to be excellent. It can operate over the worst of shell-torn battlefields, and climb grades of 45 degrees and more. The armor is sufficiently heavy to be proof against ordinary bullets and shell splinters. And because of its small dimensions—about twenty feet in total length by six feet in width—it presents a small mark for enemy guns.

(Continued on page 304)

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A fleet of "Renault" or light French tanks, with the leading one equipped with a small cannon

Photo, French Official

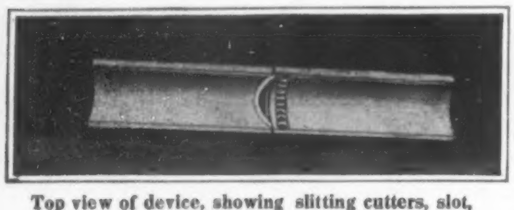
Caterpillar trucks employed in transporting "Renault" tanks to the field of battle

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

Getting Real Food Out of Corn

A COMBINATION of circumstances has resulted of late in a large surplus of corn throughout the country.



Top view of device, showing slitting cutters, slot, and squeezing blade

Household device for extracting the real food elements from ear of corn

The fact is that most farmers raise more corn than they can dispose of, and through lack of suitable means of conserving this cereal, it is only too often allowed to ferment and go to waste. Those farmers who are fortunate enough to be within a moderate distance of some of the large alcohol distilleries where solidified alcohol is made for fuel purposes, can bring their corn there and have it returned to them in the form of sweet mash, which is an excellent food for livestock. But the average farmer raises much corn that is destined to be wasted.

As a food product, corn, on the cob or canned, is by no means ideal. If an ear of corn is permitted to dry, it soon becomes evident that each grain is a woody or fibrous container for the real food substance within. It is that woody or fibrous matter that makes corn so indigestible when served in the usual manner; yet the cereal should not be condemned for that fault, since there is no reason why the woody or fibrous elements should be eaten along with the really nutritious elements.

With a view to extracting the real food elements from an ear of corn, Mrs. Louise Mitchell LeVerne of Montgomery, Ala., has invented an ingenious device which, in its simplest, household form, is shown in the accompanying illustrations. Briefly, this device consists of a table mounted on suitable standards, a battery of knives or cutters spaced $\frac{1}{16}$ inch apart, a crescent-shaped slot and a slightly-beveled-edge blade set at an angle of 45 degrees. By pushing an ear of corn along the table, the battery of knives slits several rows of grains which, on coming in contact with the large blade, are squeezed so as to give up their milky contents. A bowl or tumbler placed beneath the slot gathers the milky fluid. The ear of corn is then brought back to the starting point and rotated sufficiently to bring new rows in contact with the cutters and squeezing blade.

The milky substance obtained in the foregoing-described manner can be used in a large number of ways; indeed, it is the corn itself, in so far as the human digestive organs are concerned. It can be served as a vegetable, in soups, and in desserts of various kinds. The canning problem is readily solved in the case of this liquid corn, which can be put up in bottles, fiber and paper cans, or other containers, and readily shipped.

The corn cob is practically reduced to so much woody substance by this simple operation. However, it is available for other processes whereby certain important products can still be obtained, thus utilizing the entire ear of corn.

For household use, the simple type shown in the illustrations serves the purpose. Mrs. LeVerne has designed an automatic type of machine in which the ears are handled with a minimum of attention and in large numbers.

Stove that Packs Like a Suit Case

IF ever necessity was the mother of invention, it has been so in the case of the field stove now being employed behind our lines in France. Briefly, the story is this: Our doughboys asked for batter cakes. Immediately the Y. M. C. A., the Salvation Army, the Red Cross, and all other societies engaged in doing everything possible toward the welfare and comfort of our men, attempted to respond. But how could batter cakes be prepared for the soldiers up in the front-line trenches?

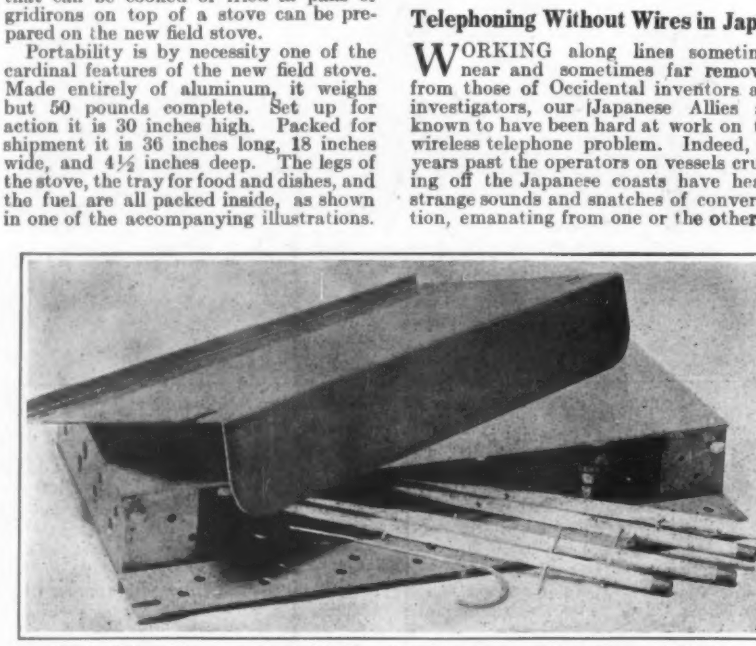
The fact is that the fuel situation in France is more or less serious at present. Coal is at a premium, and has been so for the past four years; and wood is growing scarcer because of the inroads made into the lumber resources of the Republic. The problem of a suitable stove and fuel was put up to Mr. I. Popper, the inventor of the ingenious mess kit recently described in these columns, who solved it in short order. The solution is the field stove depicted in the accompanying illustrations.

Planned primarily to cook batter cakes for our doughboys, the usefulness of Mr. Popper's field stove does not stop there. It is an ideal stove on which to make boiling hot coffee, always in demand in the Army day and night, and to cook chops, steak, chicken, bacon and eggs—in fact, anything and everything that can be cooked or fried in pans or gridirons on top of a stove can be prepared on the new field stove.

Portability is by necessity one of the cardinal features of the new field stove. Made entirely of aluminum, it weighs but 50 pounds complete. Set up for action it is 30 inches high. Packed for shipment it is 36 inches long, 18 inches wide, and 4½ inches deep. The legs of the stove, the tray for food and dishes, and the fuel are all packed inside, as shown in one of the accompanying illustrations.

The fuel for the field stove is solidified alcohol packed in half-pound cans. All that is necessary is to remove the top of a can, strike a match and the full and intense heat is instantly available. The fire can be extinguished in an instant by replacing the cover or simply blowing out the flame. This fuel is made by a newly-patented process, and does not turn to liquid while burning. It gives no smoke, odor, or soot, and cannot explode. Six cans of this fuel will heat the top of the stove ready for cooking in eight minutes. Each will burn two hours. It requires but two minutes to cook a large-sized batter cake. There is room on the field stove to cook 12 cakes at one time—12 every two minutes means 360 an hour, or an output that must come pretty close to keeping pace with our hungry fighters, when a battery of such stoves is in action.

The various organizations in France have ordered a large number of the new field stove, which, it seems, answers in every way the rigid requirements of the present war. The question of fuel is also solved.

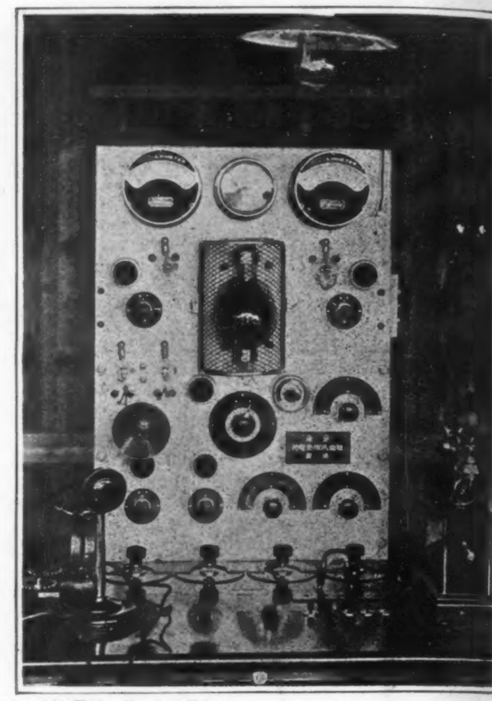


Packed for shipment, the field stove is 36 in. long, 18 in. wide, and 4½ in. deep. It weighs but 50 pounds

Using six cans of solidified alcohol for fuel, this stove can cook for the soldiers immediately behind the front-line trenches

Telephoning Without Wires in Japan

WORKING along lines sometimes near and sometimes far removed from those of Occidental inventors and investigators, our Japanese Allies are known to have been hard at work on the wireless telephone problem. Indeed, for years past the operators on vessels cruising off the Japanese coasts have heard strange sounds and snatches of conversation, emanating from one or the other of the experimental radio telephone stations.



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Wireless telephone installation designed by a Japanese radio worker

As to the present status of Japanese radio telephony, the accompanying illustration may shed some light. At any rate, it shows a recent wireless telephone installation designed by a Japanese wireless worker, Dr. Torigata. This panel type installation appears to operate on the familiar vacuum valve principle now employed in the United States and elsewhere for wireless transmission. The vacuum valve generator of waves appears in the center of the panel, protected by a wire screen.

For receiving purposes Dr. Torigata employs vacuum valves of the conventional type, of which four are shown in this case. It is probable that two are intended for the reception and detection of the incoming waves, while the other two are employed for amplifying. The remaining apparatus consists of condensers, inductances, and switches, for adjusting and controlling the currents in the various circuits.

As likely as not Dr. Torigata's system can be employed in conjunction with the regular wire telephones, such as is done in the United States. For this purpose additional apparatus is provided on the table in front of the panel. The regular horn for the wireless telephone transmitter appears at the left, just above the desk-telephone.

Cooling of Castings by Electricity

MOST metals when contracting from the liquid to the solid state in the form of castings, develop holes or other defects inside the solid castings. Were it possible to overcome this, much saving of metal and more perfection in castings would result. A novel and interesting invention has appeared in England which is aimed at just this thing—the prevention of defects in castings due to the contraction of the metal. It depends on the application of electrical heat to the thinner and less dense parts of the castings, with the object of keeping their falling temperatures the same as those of the thicker and denser parts.

As the method of application the inventor suggests casting runners or ribs on the thinnest sections and applying heat electrically by dropping electrodes into the molten metal and allowing the preliminary cooling to 1,300° C. to make the joint. In cooling, the thinner sections cool more rapidly than the thicker ones, but if an electrical current is passed through more heat will be developed in the thinner ones because they have greater electrical resistance than the thicker ones. The amount of current required would not be so large as might appear at first sight, since only losses of heat have to be replaced. It would therefore, not be anything like so great as would be required to heat bodies of metal up to the temperatures at which they are treated, and it would be designed merely to keep the thinnest portions at the same falling temperatures as the thickest ones.

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is Still Running!

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And for the other two—honesty of material and honesty of manufacture—you must look to the trucks themselves. "Consult users."

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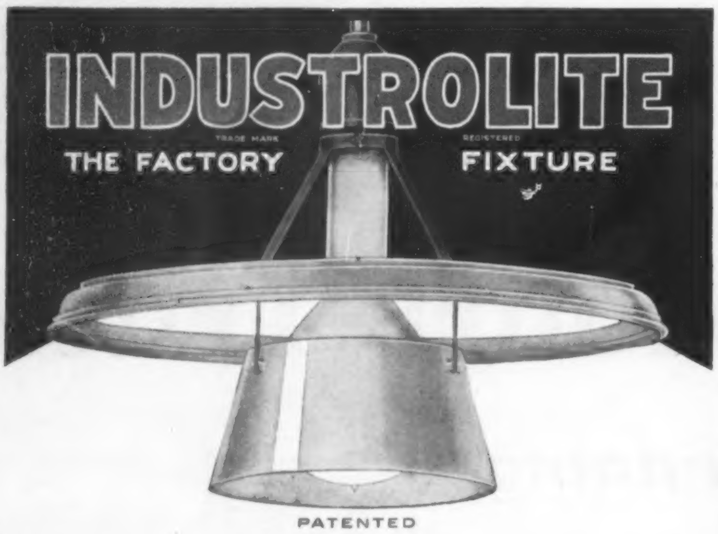

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On Government Contracts Where Night Must Be As Day

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Industrolite was developed to properly protect the eyes of industrial workers. It keeps the glare of all direct light rays from the normal range of vision. The filament of the lamp cannot be seen unless you stand almost under the lighting unit and then look up at it.

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The Current Supplement

ONE of the most prevalent troubles that the medical profession has to deal with in its war experience is an extensive class of nervous disorders resulting from shocks of various kinds. These disorders are by no means new or unknown, but in ordinary times are comparatively infrequent; under war conditions, however, when hundreds of thousands of men are constantly exposed to the effects of our tremendously powerful modern explosives, gas attacks and many other nerve wrecking modern methods of warfare, cases of this kind become much more frequent and serious. This important subject is ably reviewed by a member of the staff of an English war hospital in a paper on *The Pathology of War Neurosis*, which will be found in the current issue of THE SCIENTIFIC AMERICAN SUPPLEMENT, No. 2232, for October 12. *Chocolate and Cocoa* gives general facts in relation to the production and manufacture of an important food that is highly esteemed in private life, and in some foreign armies. A number of unusual photographs illustrate the article. The second, and concluding instalment of the article on *The Stokes Bomb-Throwing Gun*, with 14 illustrations will be found in this issue. *Electric Arc Welding in Shipbuilding* summarizes the regulations issued by "Lloyd's" in relation to this latest method of construction. *Ammonium Nitrate from Coal Gas* discusses an important process for the recovery and utilization of nitrogen, which is so greatly needed at this time. Another instalment of the series of papers on *Anomalies in the Animal World*, accompanied by illustrations appears in this issue. *Poisons and Drugs of Animal Origin* discusses the chemistry of the protective poisons of the lower animals of various glands and sera. Other articles of interest in this issue are *The Limits of Complete Inflammability of Mixtures of Mine Gases and of Industrial Gases with Air, The Mechanism of the Setting Process in Plaster and Cement, The Addition of Steel to Cast Iron* and *The Chemistry and Metallography of Aluminium.*

What Export Trade Means to American Industries

(Continued from page 287)

miner, of course, got the lion's share; but the cotton grower got \$94,800,000, and the farmer collected \$20,800,000 from the shoe industry. The logger was paid for 1,200,000,000 feet of lumber which found its ultimate use in exported wares; but we can not estimate the value of this, since the Government's figures under the head of "wood exported" take no cognizance of wooden parts which go abroad in such goods as agricultural implements, carriages, refrigerators, sewing machines, and a thousand and one other assemblies.

But the employment of more than one million men and women, and the industrial treatment of two billion dollars worth of raw materials, are not possible without the additional employment of all the other industrial equipment of the nation. Factories are required to house the work and the tools and the machinery; power must be furnished to run the factories. Of the total primary horse-power consumed by our industries, 1,174,000 units were employed in 1914 to keep in motion the machinery that made goods for export; and in 1917 this figure increased to 2,926,526 horse-power. Thousands of new factories had to be built to take care of the additional labor and machines which handled the increased manufacturing for foreign trade; transportation of the increased output would have created a problem in less disturbed times than we have had.

Three and a half billion dollars have been added to the industrial exports of the country without an apparent recourse to increased national force. There has been little immigration during the three years just gone, and many men have gone back to the country of their origin to serve in the army. Our own National Army has withdrawn three million men from other employments, and the compulsory retirement of many skilled enemy aliens has further reduced the working staffs. In many cases the situation has been met by installing women workers. But it has not been possible to increase the national labor army; the presumption, therefore, must be that much of the additional production has been made possible by increased employment of machinery, and that the additional labor which has been required in other instances was drawn from industries less affected by the general activity in the export market and from the very considerable reserve of floating labor. Better methods of production and a speeding up of the facilities of the national industries have done their part. With further improvements to be expected in the effectiveness of the machine equipment and a still better use to be made of labor saving machinery, there is no reason why even a larger industrial output might not be obtained without necessitating an increase in the labor force.

As the war has been the cause of many of the foreign orders which have reached this country during the last three years, it must be expected that a decline will take place in the nation's foreign trade when peace shall be declared. How extensive this decline will be it is impossible to say, but necessarily it must be considerable. The national industry will find sufficient compensation for the temporary loss of foreign trade in an increased activity in the home market caused by the reorientation of the economic life of the country which unavoidably must follow the war. After the completion of this process a new forward movement in our foreign trade can be expected which, however, can be hardly as pronounced as the present. Men who are in a position to judge, seem to have little doubt that it will carry our foreign trade considerably above the values of 1914. In normal times the world's foreign commerce grows at the rate of 2.5 per cent annually which represents an addition of approximately \$1,000,000,000 to the total commercial turnover between the countries of the world. The export of American industrial merchandise grew during the years before the war on a more rapid scale than this; at least 15 per cent was added every year to the country's export of industrial products. American industry, therefore, has secured a larger share of the newly developing commerce of the world than could be expected reasonably, and it is most likely that it will continue to do so after the war. There is no reason why the American exports of industrial products should not continue to grow at the rate of \$300,000,000 per annum when peace is established. The country having shown its ability to handle a sudden increase of its exports valued at \$3,500,000,000 should find no difficulty in taking care of an annual growth of its foreign trade of a few hundred million dollars. If we can secure the orders for the additional business, there is no doubt that we shall be able to produce the goods.

An annual addition of \$300,000,000 to the value of the present exports of industrial products will bring an addition of \$60,000,000 to the income of the wage earners of this country. It will mean an outlay of \$150,000,000 or more for raw materials, a large part of which will go into the pockets of the American producers, and a manufacturing profit of between \$50,000,000 and \$60,000,000 to our industry, allowing the employment of additional capital, the interest of which is paid by the foreign consumer. These figures seem small if compared with the enormous values which are employed in the operation of the national industry. We must not forget, however, that the total industrial production of the United States, as reported by the census of 1870 had a value of \$5,369,579,000 only, which is only a billion dollars more than the value of all industrial products which were exported by the United States half a century later. Much money and labor have been expended in the building up of that vast foreign trade, the largest part of which has been attained only since the beginning of the present century. Today thousands of Americans work in other countries to create new openings for the sale of American merchandise. Millions of dollars are spent for the upkeep of the nation's foreign commercial representation, for advertising, cables, and all the other incidentals of export trade. But the winnings have been worth the stakes. Today America has entered the foremost ranks as an exporter of manufactured goods. Today the world looks to the United States of America for all that it was accustomed to buy from Europe in former years.

Out-of-the-way Jobs for the Tractor

(Continued from page 290)

On the farm the superiority of tractors over horses lies in the greater amount of work they can do with the same amount of supervision. While a team of horses can only pull a single plow, a tractor can pull a battery of them. Often the same tractor will plow, harrow and drag the land all in one operation, with a tremendous saving of time on the part of the farmer. Again, the tractor can go on working at the same speed hour after hour, whereas the horses become tired and need rest. The character of the plowing done by the tractor is more uniform than that of hand plowing, and there are many instances of increased crops being produced as the result of such uniformity. Tractor plowing is also easier for the farmer, as he can sit on the machine and guide its operation, instead of following in the furrow as with horses.

The engine of a tractor, by being belted to a hay-press, silage-cutter, threshing-machine, etc., can furnish the power for operating those machines, and there is no danger from fires, such as always attended the old-fashioned steam engine. In the old days it was frequently necessary to keep up steam in the thresher all night, to have it ready for use the next morning, and there was constant danger from fire. The tractor engine is started in an instant, and uses fuel only when in operation.

If the future continues to disclose as many new uses for the tractor as have been found in the past, the day is not far distant when this machine will find a place upon almost every American farm, and in many of our other industries.

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Strategic Moves of the War

(Continued from page 292)

into Albania, where no aid can reach it. On the east of the Vardar the Bulgarians were retreating rapidly to the north and east. The British crossed the Bulgarian frontier and took the fortress of Strumitza, the Bulgarian base north of the Lake Doiran region. This success furnished easy access to the valley of the Struma River and also gave a direct road to Sofia.

The Allied armies were in position to recover the greater part of Servia; for they were nearing Uskub and also moving east from Veles to the Bulgarian borders. Serbian troops also reached points 30 miles east of Veles and were closing in on Kustendil in Bulgaria, the terminus of the railway running west from Sofia. Everything therefore pointed to an early capture of the Bulgarian capital and to an entire Allied success. The situation of Bulgaria was consequently precarious in the extreme; it is therefore not surprising that a panic prevailed in Sofia and that Bulgaria asked first for an armistice and then quickly yielded to all the Allied demands. The main terms were the demobilization of the Bulgarian army, its arms and ammunition to be turned over to the Allies; all Greek and Serbian territory still occupied by Bulgarian troops to be evacuated and all means of transportation to be placed at the disposal of the Allies. By these general terms Bulgaria was placed under Allied control and separated as an ally from Turkey on the one hand and from Austria and Germany on the other. By giving up, she cut off the most direct route from the Central Allies to Constantinople and practically made the Danube River unavailable for hostile traffic. It is therefore impossible for Germany and Austria to reach Turkey except through Rumania and the Black Sea ports. The results upon Turkey's position are serious and must be immediate, for Bulgaria has thus practically cut the cords connecting Germany, Turkey, and Asia and has given a death blow to Germany's designs in these countries.

If Turkey gives in, as she will probably do at an early date, the Allied armies in Palestine and Mesopotamia could be transferred, if needed, to the western front. If she does not yield, then the Great Allied armies with their bases at Salonica could be at once turned against her and the results would be only a question of time.

The success of the British in Palestine has been due to the skill and energy of their commander, who during the summer had been holding a front about fifteen miles north of Jerusalem and running approximately east and west from the Jordan River to the Mediterranean Sea. Opposite him in the hills of Samaria was the greater part of the Turkish forces, supplied by a railroad branching off from the Haifa-Damascus road at the village of Afule, a few miles south of Nazareth, and running down to Nabulus. The main road from Jerusalem north to Nazareth runs close to the railroad passing through El Afule, which thus became the key to the communications of the Turkish army in Central Palestine. By attacking first from the east, between Nabulus, the Jerusalem road and the Jordan, the enemy's attention was diverted to this part of the front. In the meanwhile, the main attack was made on his center and left, by which the Turkish positions were turned; and practically the entire Turkish army was captured or dispersed.

The immediate effect of the victory will be the liberation of Palestine since all the northern country can be easily cleared and a new base established at Haifa or even at Damascus, which surrenders as we go to press. The whole railroad system of southern Syria is thus controlled by the Allied troops in Palestine. The advance at present has been carried beyond Nazareth and also to the east of the Jordan River; to the north is Beirut on the Mediterranean connected by rail with Damascus, only 17 miles away from the present Allied lines. These two cities are most important centers and their capture would mean the entire disorganization of the Turkish war plans over a tremendous area.

Aleppo, only 200 miles north of Beirut, is the junction point of the Bagdad, Hedjaz and Anatolian railways; it is therefore the key to Syria and Mesopotamia. Rumor has repeatedly stated that Allied troops would be landed in the Bay of Alexandretta and would be marched to Aleppo or would cut the railroad in Anatolia at Adana, where the tracks are less than fifty miles from the sea. All communications would thus be destroyed between Constantinople, Syria and Mesopotamia. Any force assembled at Aleppo would cut off all the Turkish armies in Syria and Mesopotamia; so that, if the British succeed in reaching Beirut, now a matter of ease, all the Turkish forces in Mesopotamia must retreat to Aleppo or be captured or dispersed. At last Turkey is beginning to pay dearly for her German alliance and for throwing away the friendship of England, which had so long protected her from dismemberment by other European powers. The policy of England


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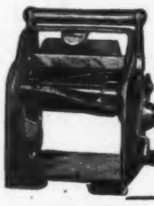

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was always defensive; it was only Britain's influence and power that has heretofore saved Turkey from extinction at the hands of Russia. Turkey was persuaded into an alliance with Germany with a view of conquering the world; today she sees her hopes shattered and her defensive strength gone, probably forever.

Outstripping Germany in the Chemical Industry

(*Continued from page 293*)

is changed. Ten years ago apparatus of fused pure silica was introduced and at once became popular since it withstands acids as well as sudden great changes in temperature. In some cases it may be used in the place of platinum. Here again really large units have but recently appeared. The production of this ware in America is a war development. Retorts up to 75 liters, crucibles to $22\frac{1}{2}$ liters, tubes to 18 inches in diameter and other large scale appliances are offered.

Filter Presses

Filtering, a most important chemical operation and frequently most perplexing, shows the place it occupies by the effort expended on mechanical devices for its accomplishment. Filter presses were an achievement, but they required much hand labor, many cloths and could only be worked intermittently. For some processes these conditions have not been overcome, but for others continuous filters may now be had. Filter press design now provides for more mechanical and less hand labor, some are nearly automatic and all are of large size. Cloth may now be replaced with metal fabric and where necessary a prepared earth may be obtained to assist in obtaining perfect filtration of substance once thought impossible of such treatment. Large thickeners are also used economically.

Pulverizing, milling, crushing and shredding are other chemical operations calling for exact workmanship in construction of heavy machinery. Material to pass a sieve having 200 meshes to the linear inch is not an uncommon specification. Its preparation frequently involves a fire or explosion hazard to avoid which the dust is carried away in air currents as rapidly as formed. Again the material, especially one type of metal, may not be capable of safe grinding and must, therefore, be sprayed molten into water. Ball mills of porcelain include miniature ones for experiments with costly substances and sizes up to those measured in tons capacity and employing selected flint pebbles for the grinding action.

Drying Apparatus

Volumes have been written on drying problems. The drying apparatus to be had, therefore, naturally presents wide differences in design and involves temperature control, humidity control, air circulation, etc. The shelf driers, the rotary ones, the ovens with shelves traveling on endless belts, all are large, heavy machines, especially where vacuum is employed to increase efficiency or to enable drying to be done at very low temperatures. Evaporators, vacuum pans, jacketed kettles and concentrators are other examples of large scale chemical machinery, usually of cast iron. Much excellent work has been done lately on protecting the surfaces of such ware against the corrosive action of the many chemicals employed in them. Enamels and glass-like materials are employed in a truly large way. The constant problem is to obtain a coating free from such small "pin holes" as would permit the iron to be reached and a reaction started which might ruin the contents of the vessel, cause deterioration of the coating or eventually destroy the vessel wall. Most of the reactions in industrial chemistry which require temperature control take place at points far above the boiling point of mercury, so that optical or electrical devices must be used when accurate results are required. These pyrometers are not large in size, but in importance. They must be protected in the furnaces, which makes work for the ceramic and mineral specialist in devising suitable protective sheaths. Pyrometers may be had which enable readings to be made in many places simultaneously. Where much is at stake the general manager's office is equipped to follow furnace temperatures at the same time as the superintendent and the furnace forman though the three may be widely separated.

Use of Electrity in Chemical Industries

Electric furnaces are also concerned in this chemical development. They may hold tons, require separate housing and consume vast quantities of electric energy. They are mechanical to a high degree and, even in large sizes, are sometimes emptied by tilting the entire furnace.

Many a plant has found its production costs made high due to the transportation of partly finished goods within the shop. Chemists, to avoid such a condition, are naturally interested in belts of leather, links, rubber or canvas, in modern conveyors, hoists, and elevators and similar devices. He requires kneading and mixing machinery as well as those wonderful automatic tablet-forming machines, stills, package-filling machines, labeling devices, big centrifugals, special wood or metal tanks and numerous pumps. Some of these are lined with stone ware and the same material is used for spirals or worms of large size, great jars, piping and trays.

In these days of important electrolytic products electrolytic cells were, of course, in the exhibit. Wonderful changes take place during the processes concerned. Salt is transformed or decomposed into sodium and chlorine, water to oxygen and hydrogen, magnesium metal made from the chloride and so on. The units are not of great size but in combination in a great plant are very imposing.

Back of all our industrial development stands the research, analytical and control laboratory, and the laboratory must have its American-made supplies. A word then to record real, fundamental progress in glassware now better than any that ever came from Germany, in porcelain, in clay crucibles, "boats," combustion tubes, accurate time saving balances, meters, and apparatus for recording photographically the changes in metallurgical and other processes. There is and always will be much to do. We would not have it otherwise, but those who attended the exhibition day after day always found something new in chemicals, in dyes and other chemical products, in apparatus and machinery to impress them with the permanency of American chemical industry and convince them that to foster it is a national duty.

Who Shall Do It?

(*Continued from page 296*)

named. Nevertheless, the War Department has surrounded it with reasonable safeguards. It will be observed that the Committee on Emergency Construction of the War Industries Board has only advisory powers. A building project, having been approved by the General Staff, is sent to the Construction Division to be carried into execution. That division addresses the Committee on Emergency Construction with a formal communication giving the salient features of the operation and such collateral information as it knows will be useful in the consideration of the question, and asks that recommendation of contractor be made. In the Committee on Emergency Construction the files are carefully gone over and by a process of elimination, which weighs all aspects of the question and considers the names of all the available concerns, a contractor is recommended. That recommendation is returned to the Construction Division through the Director of Purchases who must approve it. The Construction Division, if it concurs in the recommendation, forwards it to the Secretary of War's office where final approval is made and the papers are then returned to the Construction Division which notifies the contractor that it is ready to make a contract with him. In all this routine the War Department holds everyone concerned to the strictest accountability for his acts. It is not uncommon for the Assistant Secretary of War to call for special hearings on a recommendation, at which time the Committee on Emergency Construction has to present its files and documents and show the reasons for any conclusions reached.

The system may have many defects but it has the all-important advantage of saving time—vast quantities of it—for it enables the Government to proceed immediately with its work with contractors of whose ability and experience it has intimate knowledge. It also saves money, for it is inconceivable that so enormous and varied a building program could be prepared for competitive bids; and, in the absence of complete information, bids are the most elusive and wasteful things that can be injected into emergency work. Bids, while they would allay the possible distrust that is evinced in some quarters when such enormous undertakings are put on a basis that seems partially fiduciary, would simply engender a false sense of security while the waste of time and money would go on unobserved, nevertheless insidiously undermining the very foundation of our war preparation. We have seen in former articles that the system employed has its well established counterpart in the peace-time practice of the industry, but emphasis should be laid on the most patent phase of the system. The officers charged with the administration of this great building program should be relieved of every consideration excepting the single one of getting it through on time; of all considerations of barter and trade and responsibility for arithmetical comparisons they should be relieved, so long as the program is conducted on the basis of starting the work before complete plans and specifications are available.

The position taken by the Government that it is aiming to obtain brains and efficiency and that in this crisis it has no time for barter and gamble over its all-important building program, is unassailable and has been the means of saving untold time and money and bringing its construction program through without one single justifiable complaint that the war preparation has been delayed for want of proper progress in the building program.

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Some Tools of the German Airmen

(Continued from page 297)

airman pulls handle *A* and puts a suitable distance between himself and his machine. It requires seven or eight minutes for the "destroyer" to explode and wreck the airplane. Incidentally, it may be added that the casing of this apparatus is designed to resist ordinary and even armor-piercing bullets.

For flying at great altitudes, such as 22,000 feet which is often attained by some two-seater machines of the Germans, it is necessary to provide some form of oxygen supply for the airmen. In the case of the two-seater Rumplers, which are employed by the enemy for long-distance reconnaissance, an oxygen apparatus is placed behind the observer, in the fuselage, with two rubber tubes leading to the observer and pilot, respectively. The observer regulates the supply of oxygen. The complete apparatus weighs about sixteen pounds.

By referring to the third sketch, it will be noted that the German oxygen apparatus consists of a vacuum flask, *V*, containing oxygen in liquid state; a refilling stopper, *B*; outlet tube, *T*; choke chambers or "detention chambers," *D* and *D'*; expansion or warming coils, *S S S*; needle valve for regulating oxygen supply, *R*; rubber bag for regulating the pressure, *C*; respirator members of airmen, *P P*; pressure indicator, *M*; and safety valve, *O*.

Still another piece of equipment on board many two-seater German machines is a "telegraph" system for insuring communication between pilot and observer. Instead of an electrical system, such as is commonly employed on American and Allied craft, the Germans employ two dials with indicator hands which are moved in synchronism by means of silk cords passing through metal tubes. Either dial can be set to any desired message, such as "German airplane," "Enemy airplane in front," "Enemy airplane behind," "Artillery is firing at us," "I am wounded," "Machine gun jammed," and "Return over the objective," whereupon the companion dial is also set to correspond by means of the silk cords connecting them.

Wireless direction finders, operating in conjunction with large German wireless stations, are employed on the larger, long-distance bombers. Compensating compasses, altitude meters, speed indicators, recording altitude meters, first aid kits, and other equipment are now carried on most German machines.

The Lightweight or "Renault" Tank of the French

(Continued from page 297)

The "Renault" tanks are brought to a battlefield on flat cars and motor trucks, and kept at the rear of the massed soldiery until the dawn of the attack. Signal equipment, including wireless apparatus, is carried by these tanks, in order to ensure communication between them and the infantry units. Camouflage of various kinds, from protective coloring schemes to grass mats, is resorted to in protecting the tanks while in action. Camouflage covers are employed to conceal the tanks when at rest.

Where Battle Waste Is Salvaged

A GOOD deal has been said about the recovery of used metals from the battlefields of France and their re-use; but is doubtful that the magnitude of this business has been realized. It is actually carried out on such a large scale that there is not room or time or labor enough for it in France, and much of the salvaged stuff has to be shipped to England for re-working.

The headquarters for this work are in Swansea, Wales. There are located here two large firms which have always carried on a notable business in the salvage of warships and cargo-carrying vessels. Within the last six months their activities have been extended, under governmental auspices, to the battle waste received from the continent. Formerly, under an agreement between the two governments, the French engineering service undertook the heavy task of collecting the salable scrap from the battlefields of the western front and working it over into iron and steel bars. But, as suggested, the accumulation of material was so heavy as to necessitate the transfer of much of this work to Britain.

One reason for selecting Swansea as the base for this service is that within twenty miles of the city are found 80 per cent of the tin and terne mills of the United Kingdom.

The entire industry is under Government control. Although half the tinplate mills in the district have been closed on account of Government restrictions, a certain amount of tin plate is required by the Ministry of Munitions; so licenses are granted to manufacturers of this article for the purchase of raw materials and especially scrap iron. The reclaimed steel bars not thus used in the making of tinplate are shipped to other parts of the country, where they are rolled into sheet form for use in the manufacture of trench shelters.

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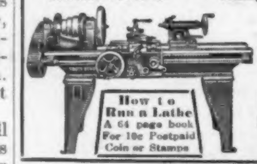

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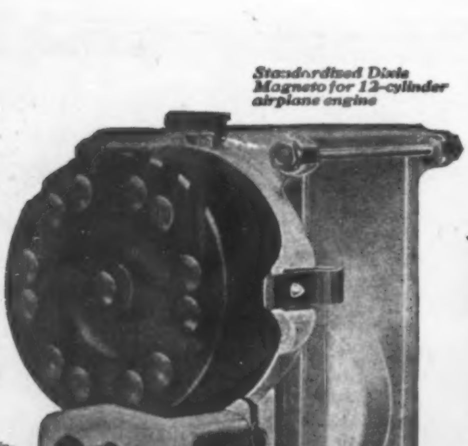

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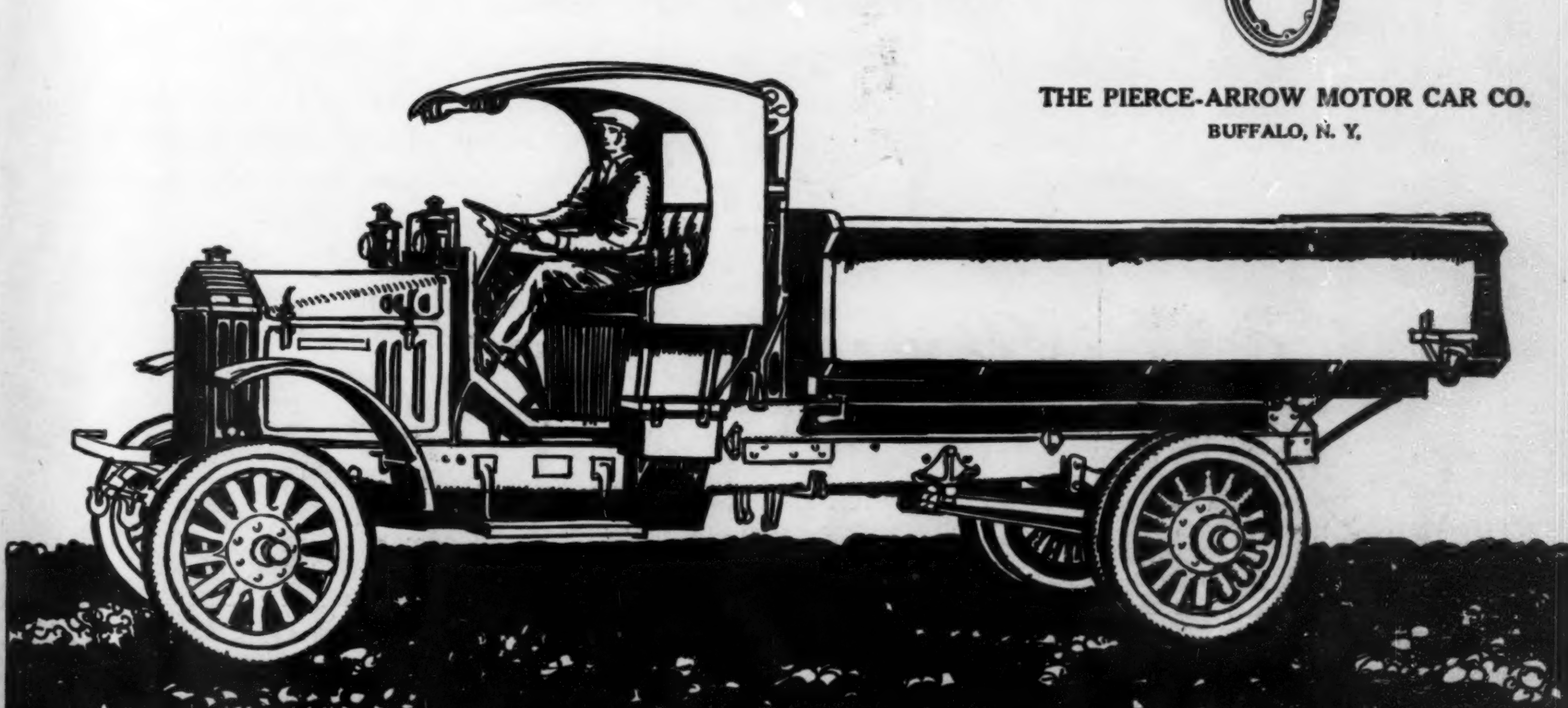

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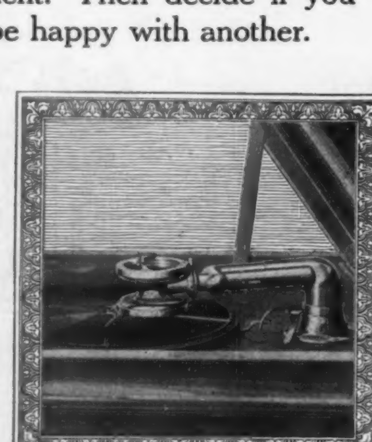

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